Table 2.9. Habitat variables and coefficients for population-level winter mule deer resource selection probability functions (RSPF) before and during 4 years of natural gas development in western Wyoming, 1998-2004.

Variable	Pre-Development[a]			Year 1			Year 2			Year 3			Year 4		
	β	SE	P	β	SE	P[b]	β	SE	P[c]	β	SE	P[d]	β	SE	P[d]
Intercept	-29.649	6.637	<0.001	-84.56	21.12 4	0.003	-75.712	12.93	<0.001	- 104.29 5	11.316	<0.001	-60.949	13.117	<0.001
Elevation	0.009	0.001	<0.001	0.031	0.008	0.005	0.027	0.005	<0.001	0.036	0.004	<0.001	0.022	0.006	0.003
Slope	0.098	0.010	<0.001	0.391	0.073	<0.001	0.258	0.046	<0.001	0.342	0.128	0.036	0.472	0.078	<0.001
$Slope^2$	-0.004	0.001	<0.001	-0.022	0.004	<0.001	-0.017	0.003	<0.001	-0.019	0.007	0.042	-0.025	0.005	<0.001
Well distance	na			3.129	1.899	0.134	3.375	1.264	0.018	6.712	2.394	0.031	na		
Well $distance^2$	na			-0.465	0.229	0.073	-0.416	0.156	0.019	-0.719	0.289	0.047	na		
Road density	-0.249	0.027	<0.001	-0.827	0.387	0.061	ns			ns[e]			0.675	0.615	0.299
Road $density^2$	ns			ns			ns			ns			-0.624	0.128	<0.001
Aspect = NE	0.012	0.051	0.818	ns			ns			ns			na		
Aspect = NW	0.399	0.025	<0.001	ns			ns			ns			na		
Aspect = SE	-0.301	0.222	<0.001	ns			ns			ns			na		
Aspect = SW	0.194	0.028	<0.001	ns			ns			ns			na		

2.4.6.2 Year 1 of Development: Winter 2000-01

Individual models were estimated for 10 radiocollared deer during the winter (1 January to 15 April) of 2000–01. Eight of the ten deer had positive coefficients for elevation and negative coefficients for road density, indicating selection for higher elevations and low road densities. Based on the relationship between the linear and quadratic terms for slope and distance to well pad variables, all 10 deer selected for moderate slopes and 7 of 10 deer selected areas away from well pads.

The population–level RSPF was estimated from 18,706 GPS locations collected from 10 radiocollared deer during the winter of 2000–01 (Table 2.9). The RSPF included elevation, slope, road density, and distance to well pad (Table 2.9). Deer selected for areas with higher elevations, moderate slopes, low road densities, and away from well pads. Habitat units with the highest probability of use (Figure 2.21) had an average elevation of 2,266 m, slope of 5 degrees, road density of 0.16 km/km^2, and were 2.7 km away from the nearest well pad. Predictive maps indicate probability of deer use was lowest in areas close to well pads and access roads (Figure 2.21). Shifts in deer distribution between pre-development and Year 1 of development were evident through the changes in the 4 deer use categories (Table 2.10). Of the habitat units classified as high deer use prior to development, only 60% were classified as high deer use during Year 1 of development. Of the areas classified as low deer use prior to development, 58% remained classified as low deer use during Year 1 of development.

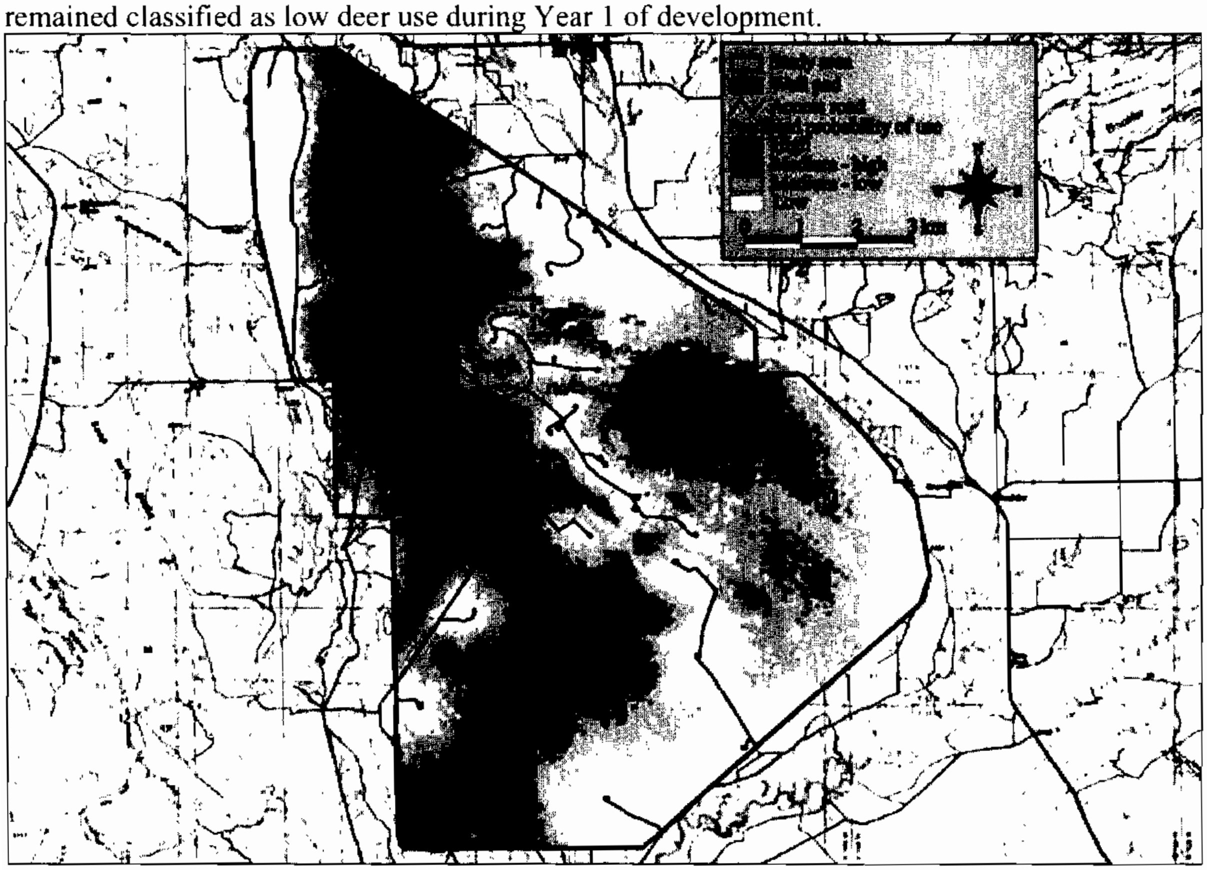

Figure 2.21. Predicted probabilities and associated categories of mule deer habitat use during Year 1 (winter of 2000-01) of natural gas development in western Wyoming.

2.4.6.3 Year 2 of Development: Winter 2001-02

Individual models were developed for 15 radiocollared deer during the winter (4 January to 15 April) of 2001–02. Fourteen of the 15 deer had positive coefficients for elevation, indicating selection of higher elevations. Based on the relationship between the linear and quadratic terms for slope and distance to well pad variables, all 15 deer selected for moderate slopes and 12 of 15 deer selected areas away from well pads.

The population–level RSPF was estimated from 14,851 GPS locations collected from 15 radiocollared deer during the winter of 2001–02 (Table 2.9). The RSPF included elevation, slope, and distance to well pad (Table 2.9). Deer selected for areas with higher elevations, moderate slopes, and away from well pads. Habitat units with the highest probability of use (Figure 2.22) had an average elevation of 2,255 m, slope of 5 degrees, and were 3.1 km away from the nearest well pad. Predictive maps indicate probability of deer use was lowest in areas close to well pads (Figure 2.22). Shifts in deer distribution between pre-development, Year 1, and Year 2 of development were evident through the changes in the 4 deer use categories (Table 2.10). Of the habitat units classified as high deer use prior to development, only 49% were classified as high deer use during Year 2 of development. Of the areas classified as low deer use prior to development, 48% remained classified as low deer use during Year 2 of development.

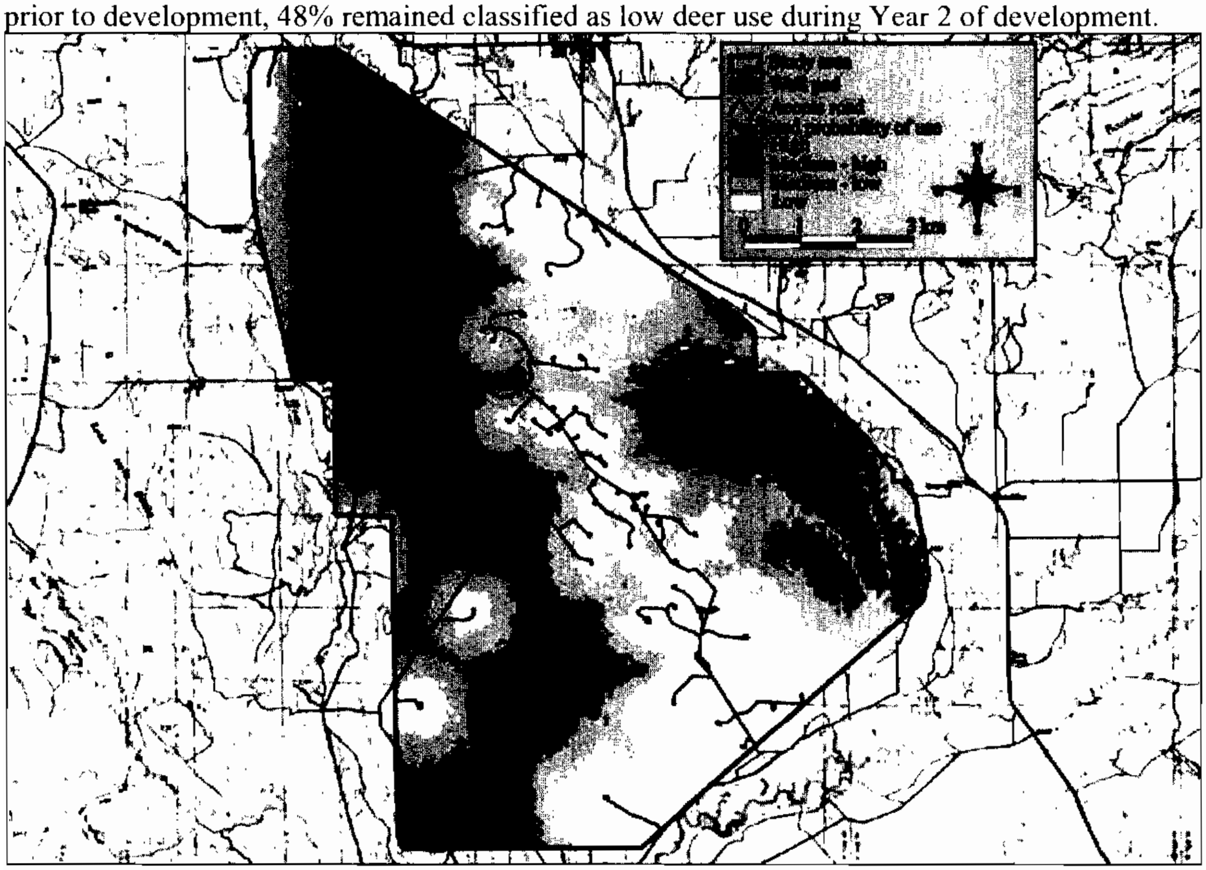

Figure 2.22. Predicted probabilities and associated categories of mule deer habitat use during Year 2 (winter of 2001-02) of natural gas development in western Wyoming.

2.4.6.4 Year 3 of Development: Winter 2002-03

Individual models were developed for 7 radiocollared deer during the winter (20 December to 15 April) of 2002–03. All 7 deer had positive coefficients for elevation, indicating selection of higher elevations. Based on the relationship between the linear and quadratic terms for slope and distance to well pad variables, 6 of 7 deer selected for moderate slopes and 6 of 7 deer selected areas away from well pads.

The population–level RSPF was estimated from 5,131 GPS locations collected from 7 radiocollared deer during the winter of 2002–03 (Table 2.9). Our target sample of 10 marked animals was not met because 3 deer died early in the season. The RSPF included elevation, slope, and distance to well pad (Table 2.9). Deer selected areas with high elevations, moderate slopes, and away from well pads. Habitat units with the highest probability of use (Figure 2.23) had an average elevation of 2,233 m, slope of 5 degrees, and were 3.7 km away from the nearest well pad. Predictive maps indicate probability of deer use was lowest in areas close to well pads (Figure 2.23). Shifts in deer distribution between pre-development, Year 1, Year 2, and Year 3 of development were evident through the changes in the 4 deer use categories (Table 2.10). Of the habitat units classified as high deer use prior to development, only 37% were classified as high deer use during Year 3 of development. Of the areas classified as low deer use prior to development, 41% remained classified as low deer use during Year 3 of development.

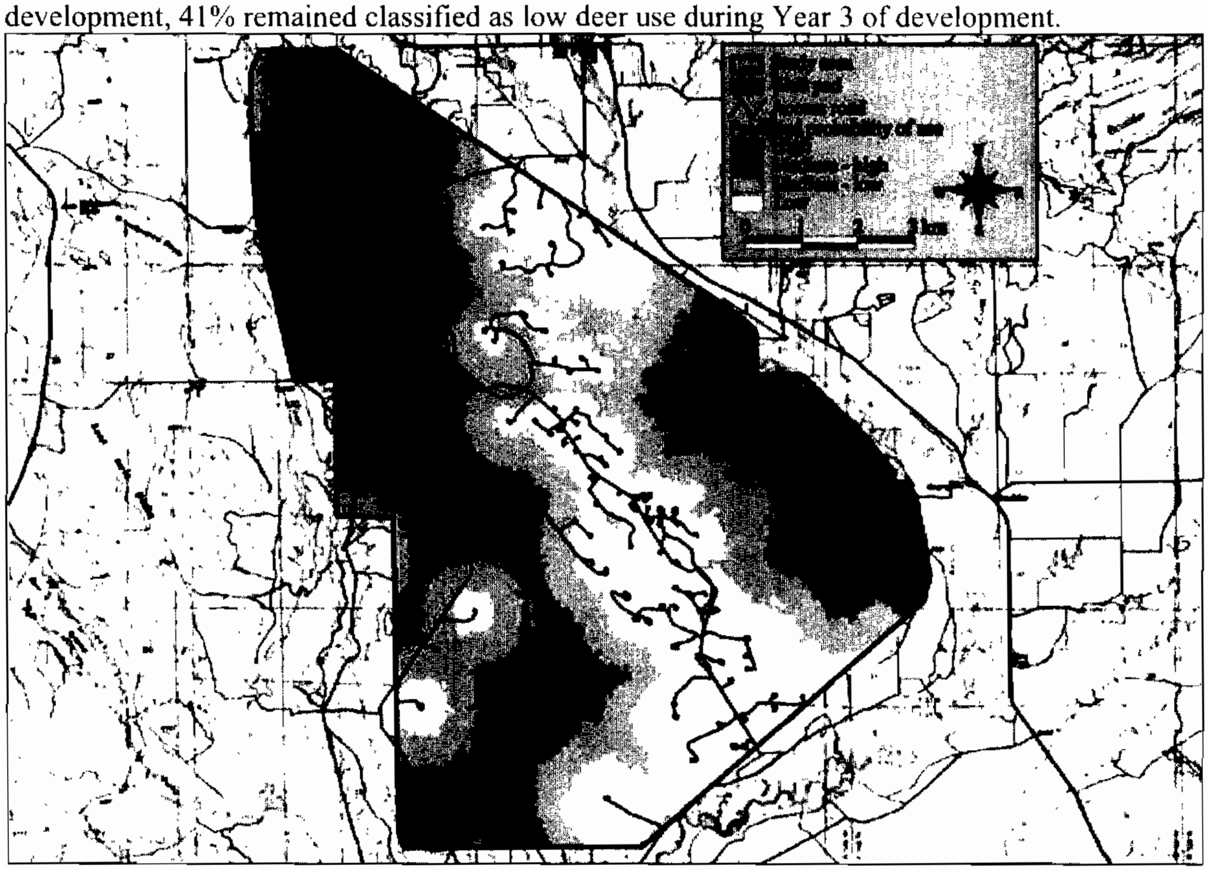

Figure 2.23. Predicted probabilities and associated categories of mule deer habitat use during Year 3 (winter of 2002-03) of natural gas development in western Wyoming.

2.4.6.5 Year 4 of Development: Winter 2003-04

Individual models were estimated for 11 radiocollared deer during the winter (20 December to 15 April) of 2003–04. Nine of eleven deer had positive coefficients for elevation, indicating selection for higher elevations. Based on the relationship between the linear and quadratic terms for slope and road density variables, 10 deer selected for moderate slopes and all 11 deer selected areas with low road density.

The population–level RSPF was estimated from 12,207 GPS locations collected from 11 radiocollared deer during the winter of 2003–04 (Table 2.9). The RSPF included elevation, slope, and road density (Table 2.9). Deer seleeted for areas with higher elevations, moderate slopes, and low road densities. Habitat units with the highest probability of use (Figure 2.24) had an average elevation of 2,276 m, slope of 8 degrees, and road density < 1.2 km/km^2. Predictive maps indicate probability of deer use was lowest in areas with high road densities and areas along the peripheral of the study area (Figure 2.24). Aside from the areas with high road densities, the probability of deer use between pre-development and Year 4 of development was more similar than during Years 1-3 of development, as evidenced through the changes in the 4 deer use categories (Table 2.10). Of the habitat units classified as high deer use prior to development, 71% were classified as high deer use during Year 4 of development. And, of the areas classified as low deer use prior to development, 77% remained classified as low deer use during Year 4 of development.

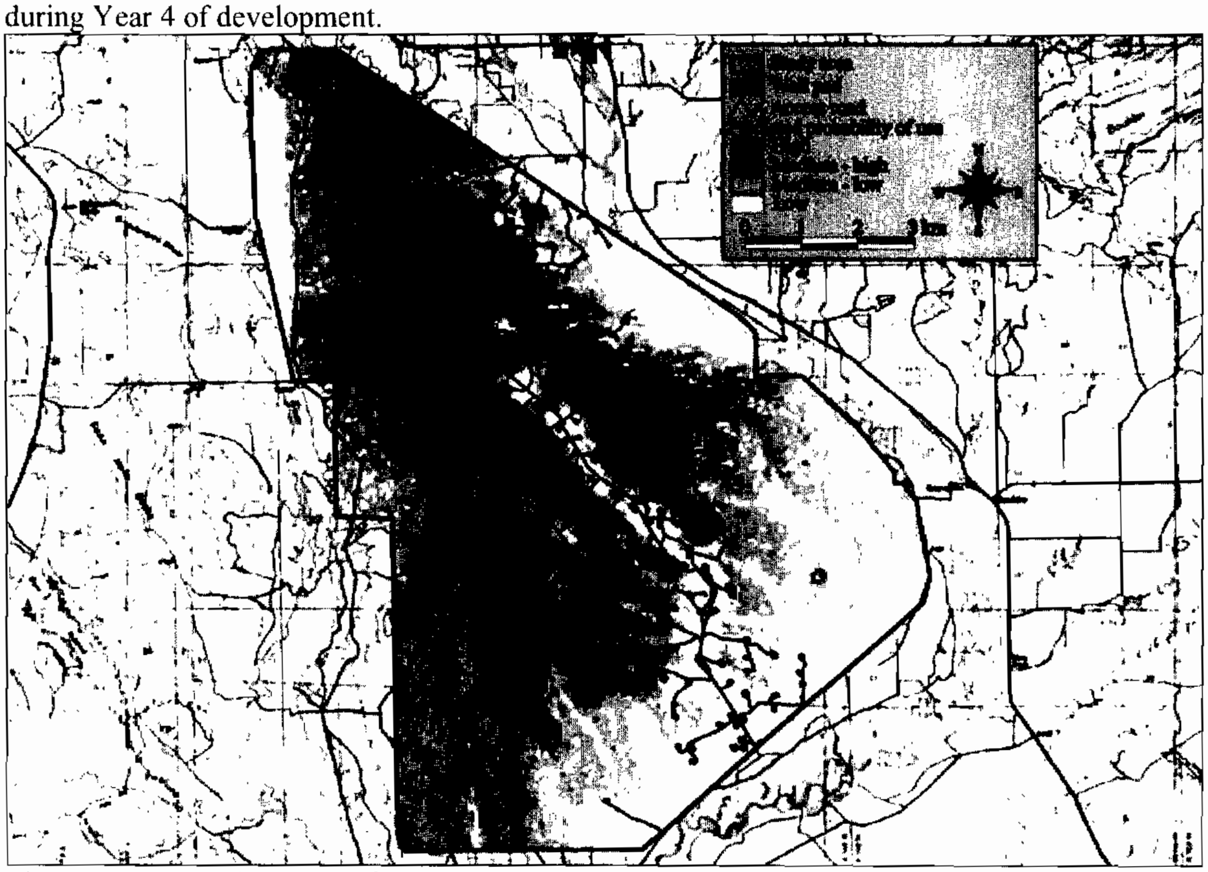

Figure 2.24. Predicted probabilities and associated categories of mule deer habitat use during Year 4 (winter of 2003-04) of natural gas development in western Wyoming.

Table 2.10 Percent change in the 4 pre-development deer use categories through 4 years of natural gas development in western Wyoming.

Pre-development category[a]	Year of development	High	Medium-High	Medium-Low	Low
High	Year 1	60%	23%	13%	4%
	Year 2	49%	19%	23%	9%
	Year 3	37%	22%	27%	14%
	Year 4	71%	23%	3%	2%
Medium-High	Year 1	31%	36%	22%	11%
	Year 2	34%	23%	25%	18%
	Year 3	27%	22%	28%	22%
	Year 4	25%	49%	22%	4%
Medium-Low	Year 1	9%	34%	31%	26%
	Year 2	16%	35%	25%	25%
	Year 3	25%	27%	25%	23%
	Year 4	4%	26%	53%	17%
Low	Year 1	0%	7%	34%	58%
	Year 2	1%	23%	27%	48%
	Year 3	11%	29%	20%	41%
	Year 4	0%	2%	22%	77%

[a] Category rows may not sum to exactly 100% because of rounding error

2.5 DISCUSSION

Currently, we collect 25,000 to 30,000 locations per year from 20 GPS-collared deer and approximately 400 locations from 40 VHF radio-collared deer. In previous years, the GPS collection schedule has been restricted to the winter (1 November – 15 April) however, beginning in 2005 we deployed new collars that will collect GPS locations on a year-around basis. These data will add to our knowledge of migration routes and seasonal distribution patterns of the Sublette mule deer herd. We plan to continue equipping deer with GPS collars for consecutive years. Although data analysis is delayed a full year when GPS collars operate on the same deer for two consecutive years, acquiring movement and distribution information from the same animal over a period of years provides useful year-to-year comparisons. For example, during the 2002-03 winter we were able to demonstrate that deer on the Mesa wintered farther north than in previous years. And, during the harsh 2003-04 winter we were able to document weather-related shifts in distribution. And, for the last several years we were able to illustrate the strong annual fidelity that deer have for the 50-mile migration route along the Pinedale Front. Additionally, as levels of development continue to increase in the PAPA, it will be important to monitor the same deer for consecutive years to determine whether emigration to other winter ranges is occurring.

Basic distribution maps generated from GPS data illustrated winter distribution patterns of deer in the control (Pinedale Front) and treatment (Mesa) areas, demonstrated the importance of BLM lands, and continued to refine information on migration routes and seasonal ranges. Deer in the treatment area continued to utilize the TPB as a migratory route between winter and spring/fall transition ranges. Deer movements through the TPB were quick (< 2 hours), as evident by the distance between locations, but the TPB continued to function effectively during 2004 and 2005. Agencies, industry, NGO's, and the public recognize the value of maintaining this movement corridor for the Sublette deer herd. Land-use decisions in and adjacent to the TPB should consider the migration routes and seasonal ranges of the Sublette deer herd.

Consistent with previous years, deer distribution and movement patterns in the control area were variable during the 2004-05 winter. The core winter range around Buckskin Crossing was heavily used, but deer shifted areas of use (10–15 miles) in all directions; south to Elk Mountain, southeast along the Big Sandy, easterly to the Little Sandy and Prospects, and northerly to Muddy Mountain. The ability to alter their rates of movements, to change their pathways, and occupy a variety of winter habitats as needed are behaviors that likely allow these deer to best exploit winter ranges. However, the unpredictable movement patterns made calculation of abundance and density estimates difficult, as the size of the sampling frame progressively increased from 2002 through 2004 to encompass the range of our marked deer. Because the sampling frame did not reflect the area utilized by our marked population prior to 2004, abundance and density estimates are expected to be biased high during 2002, and biased low during 2003.

Although winter distribution patterns varied among deer in the control area, the migration route to northerly transition and summer ranges was surprisingly consistent. All GPS-collared deer captured in the Pinedale Front migrated along a distinct movement corridor located at the base of the Wind River Range. Deer followed a well-defined route that narrowed to ¼-mile in some areas (i.e., Boulder Lake, Fremont Lake), but rarely exceeded 1-2 miles in width. GPS data

collected from individual deer for consecutive winters showed a strong affinity for this migration corridor during both spring and fall migrations. Deer that winter in the Pinedale Front were known to migrate northerly along the Wind River Range to the New Fork Lake area, before shifting their migration in a westerly direction towards the Hoback Basin and adjacent mountain ranges (Sawyer and Lindzey 2001). However, details of this migration route, in terms of size, width, specific location, and deer fidelity were unknown prior to GPS data collected over the last three years. Although these deer may migrate 100 miles between winter and summer ranges (Sawyer and Lindzey 2001), our GPS collars have not previously collected locations May through October, and therefore did not record the entire migration route(s). Deer management in the Sublette DAU is complicated by the long-distance migrations that occur through a variety of habitats and across a mix of land ownership. Knowledge of this migration route should provide agencies with the necessary information to maintain deer movements through the Pinedale Front, adjust harvest strategies accordingly, and prioritize habitat enhancement projects. Because several thousand mule deer rely on this migration corridor to access their seasonal ranges, maintenance of the corridor should be a priority for agencies, industry, and conservation groups.

In addition to basic distribution and movement maps, GPS data can be used to conduct more rigorous scientific analyses, such as estimation of resource selection models (Manly et al. 2002). Resource selection, as described by Manly et al. (2002), is a rapidly advancing methodology for analyzing, modeling, and interpreting wildlife field studies. Resource selection analyses have broad applications, and in the case of this study, were used to determine how mule deer use their habitats in relation to various habitat features, including well pads and road networks associated with energy development. Our basic approach to resource selection treats the GPS-collared deer as the experimental unit and estimates a population-level model (i.e., resource selection probability function [RSPF]), so inference can be made to the entire population of mule deer on the Mesa.

Sample size, in this case the number of collared mule deer, is an important consideration for statistical procedures that rely on simple random sampling to obtain population-level inference. We recognize the number of marked animals in our analysis may appear low, but we believe our sample adequately represents the Mesa deer population because of our *a priori* knowledge of deer movement and distribution patterns. Sawyer and Lindzey (2001) studied the movement and distribution patterns of this mule deer population for three years (1998-2000) prior to gas field development. Their results indicated that most deer congregate in the northern portion of the study area during early winter, before moving on to their respective winter ranges. Our sampling design incorporated this knowledge by obtaining a random sample of deer for collaring while they were congregated on the northern portion of the study area. Thus, while our sample sizes may be less than preferred, we believe our sampling strategy and model-building process adequately represents the PAPA deer population. We believe larger sample sizes should reveal the same relationships between the probability of mule deer habitat use and environmental conditions, but with higher precision.

Prior to this study, descriptions of how mule deer respond to gas development were generally based on anecdotal field observations. Two of the major shortcomings with anecdotal field observations are; 1) animals being observed may not be representative of the population, and, 2) animals may move to other areas when not being observed. Our resource selection analysis

accounts for the first shortcoming by obtaining a random sample of mule deer and treating the animal as the experimental unit. The random sample results in each animal having the same probability of capture and is more likely to be representative of the population than simply making observations of the most visible animals. Treating the marked animal as the experimental unit also ensures that all animals are weighted equally in the analysis. For example, some deer may use habitats in close proximity to roads and well pads, while others may use habitats away from roads and well pads. But, because all deer are treated equally, no one deer will influence model results more than another. Our analysis accounts for the second shortcoming by using GPS data that is collected every 2 hours for the entire winter, irrespective of time of day or weather conditions. This type of data collection provides accurate and unbiased documentation of animal movements through the entire winter period.

We view our resource selection analysis as an objective means to document mule deer behavioral response to natural gas development and quantify indirect habitat losses through time. Although indirect impacts associated with human activity or development have been documented in elk (Lyon 1983, Morrison et al. 1995, Rowland et al. 2000), data that suggest similar behavior in mule deer (Rost and Bailey 1979, Freddy et al. 1986, Yarmaloy et al. 1988, Merrill et al. 1994, Taylor and Knight 2003) are limited and largely observational in nature. Specific knowledge of how, or if mule deer respond to natural gas development does not exist in the literature. The resource selection analysis presented in this report is the only multi-year study that examines the effects of natural gas development on mule deer. Although this study is proposed to run several more years, results to date suggest that winter habitat selection and distribution patterns of mule deer have been affected by well pad development. Changes in habitat selection by mule deer appeared to be immediate (i.e., Year 1 of development) and through 3 years of development, we found no evidence they acclimated or habituated to well pads. Rather, mule deer had progressively higher probability of use in areas farther away from well pads as development progressed; preferring areas 2.7, 3.1, and 3.7 km away from well pads in Years 1, 2, and 3, respectively.

Population–level models and associated predictive maps were useful tools for illustrating changes in habitat selection patterns through time. We recognize the 4 levels of habitat use were subjectively defined and could vary depending on study objectives. Nonetheless, we believe models and associated predictive maps provide a useful framework for quantifying indirect habitat losses by measuring the changes (e.g., percent or area) in habitat use categories through time. Predictive maps suggest that some areas categorized as high use prior to development, changed to low use as development progressed, and other areas initially categorized as low use changed to high use. For example, following Year 1 of development 17% of units classified as high use before development had changed to medium–low or low use, and by Year 3 of development, 41% of those areas classified as high use before development had changed to medium–low or low use. Conversely, by Year 3 of development, 40% of low use areas had changed to medium–high or high use areas. Assuming habitats with high probability of use prior to development were more suitable than habitats with lower probability of use, these results suggest natural gas development on the Mesa displaced mule deer to less suitable habitats.

Interestingly, the model from Year 4 did not contain the distance to well pad variable and mule deer habitat selection was not influenced by proximity of well pads. Without the influence of

well pads, the predictive map looked remarkably similar to pre-development distribution patterns. This distribution pattern probably reflects the heavy snow conditions during Year 4 (2003-04); the most severe winter since this study began in 1998. The heavy snow conditions likely reduced the options and available habitat to deer such that they reverted to their traditional (i.e., pre-development) or available habitats, which were located in areas now covered by or in close proximity to well pads. Given the mild winter in Year 5 (i.e., winter 2004-05), we expect the Year 5 model to include the distance to well pad variable and the predictive map should look similar to those from Years 1 through 3. The analysis from Year 5 is expected to be complete in the summer of 2006.

A single well pad typically disturbs 3 to 4 acres of habitat; however, areas with the highest probability of deer use were 2.7, 3.1, and 3.7 km away from well pads during the first 3 years of development respectively. There are two potential concerns with the apparent avoidance of well pads by mule deer during Years 1 through 3 of development. First, the avoidance or lower probability of use of areas near wells creates indirect habitat losses of winter range that are substantially larger in size than the direct habitat losses incurred when native vegetation is removed during construction of the well pad. Habitat losses, whether direct or indirect, have the potential to reduce carrying capacity of the range and result in population–level effects (i.e., reduced survival, reduced reproduction, or emigration). Second, if deer do not respond by vacating winter ranges, distribution shifts will result in increased density in remaining portions of the winter range, exposing the population to greater risks of density–dependent effects. Consistent with Bartmann et al. (1992), we would expect fawn mortality to be the primary density–dependent population regulation process because of their high susceptibility to over-winter mortality (White et al. 1987, Hobbs 1989).

We continue to monitor four population parameters to detect changes in the treatment and control areas, including: 1) recruitment, 2) adult doe survival, 3) over-winter fawn survival, and 4) abundance. Recruitment (i.e., doe:fawn ratios) in the treatment and control areas has been essentially the same since development began. Estimates of over-winter adult survival have been lower in the treatment area for 3 of the 5 years since development began, and over-winter fawn survival has been lower 4 of 5 years. The only year over-winter fawn survival was not lower in the treatment was in the harsh winter of 2003-04, when we would expect high fawn mortality in both treatment and control areas. While these individual point estimates of over-winter adult and fawn survival were not statistically different between treatment and control areas, the long-term trends suggest deer in the treatment may not be performing as well as deer in the control.

Of particular concern is the decreasing abundance estimates in the treatment area, dropping from 5,228 in 2002 to 2,818 in 2005. This 4-year, 46% reduction in deer abundance is disconcerting because there is no concurrent evidence of a population decline in the control area. At this point in time we cannot detect any positive or negative trends in the control area, but abundance in the treatment area has significantly declined since 2002. Following the severe winter and associated high mortality rates in 2003-04, we expected deer abundance to increase the following year in both treatment and control areas, given the exceptionally mild 2004-05 winter. While an increase was evident in the control area, abundance continued to decline in the treatment area.

Population change is generally a function of four components, including; births, deaths,

immigration, and emigration. Ideally, we could explain how each of these components has contributed to the population decline in the treatment area. However, our population monitoring was designed to make comparisons between treatment and control areas, rather than model population dynamics (White 2000). But, based on the population parameters we have measured, we believe reduced over-winter fawn survival, lower adult survival, and emigration are likely responsible for the population changes on the Mesa. The first GPS-collared deer to emigrate from the Mesa and occupy a new, distinct winter range was documented during the 2003-04 winter (see Section 2.4.3). While this behavior was only documented in one of eleven GPS-collared deer that winter, it may have represented 9% of the population, or approximately 320 deer (i.e., 9% of 3,564).

Long-term monitoring programs will continue to provide the best opportunities for detecting changes in population parameters and to verify the magnitude of these apparent impacts of development on mule deer performance. As we continue to measure population parameters and examine habitat selection in treatment and control areas, comparisons can be made, and over time, the impacts of energy development on mule deer will be better understood. For this study, the number of captured deer or counted deer may refine the precision of the measurement (e.g., survival, reproduction), but the strength of this monitoring plan and robustness of the conclusions will be determined by the number of years it is implemented. Future monitoring should be modified to incorporate any changes in development plans, such as winter drilling. Assuming winter drilling occurs on federal lands beginning in the 2005-06 winter, we plan to evaluate how different levels of human activity (e.g., traffic) at developing and producing well pads influence mule deer distribution. Understanding mule deer response to different levels of human activity and types of well pads would allow mitigation measures to be evaluated and improved.

2.6 SUMMARY AND MANAGEMENT IMPLICATIONS

The objective of this monitoring effort is to evaluate potential impacts of natural gas development on mule deer in terms of: 1) direct habitat loss, 2) changes in habitat selection, and 3) population performance.

- **Direct Habitat Losses:** Satellite imagery was used to estimate direct habitat losses (i.e., surface disturbance) for the Mesa portion of the PAPA. Through August 2004, approximately 1,029 acres had been disturbed, of which 79% was due to well pad construction and 21% to access roads. Each year development has progressed, well pads account for relatively more direct habitat loss than access roads. Pipelines and seismic tracks *were not* included in the estimates of direct habitat loss.

- **Habitat Selection Patterns:** During Years 1 through 3 of gas development, habitat selection models and predictive maps suggested mule deer were less likely to occupy habitats in close proximity to well pads than those farther away. Changes in habitat selection appeared to be immediate (i.e., Year 1 of development) and no evidence of well pad acclimation occurred through the first 3 years of development, rather deer selected areas farther from well pads as development progressed. The lower levels of deer use within 2.7 to 3.7 km of well pads suggested indirect habitat losses may be substantially larger than direct habitat losses. Additionally, some areas classified as high deer use prior to development changed to areas of low use following development. If areas classified as high use before development were those preferred by deer, then observed shifts in their distribution were towards less preferred and presumably less suitable habitats. During Year 4 of development and following a substantial reduction in deer abundance, habitat selection patterns of deer were influenced by road density, but not proximity of well pads. This may be an artifact of the unusually severe winter during Year 4, where movement options and available habitat for deer were limited. Results from Year 5 should help clarify trends in habitat selection.

- **Population Performance:** We monitored four population characteristics to compare population performance in the treatment (Mesa) and control (Pinedale Front) areas, including: 1) recruitment, 2) over-winter adult doe survival, 3) over-winter fawn survival, and 4) abundance. Recruitment (i.e., doe:fawn ratios) in the treatment and control areas has been essentially the same since development began. Point estimates of over-winter adult survival have been slightly lower in the treatment area for 3 of the 5 years since development began, and over-winter fawn survival has been slightly lower 4 of 5 years. The only year over-winter fawn survival was not lower in the treatment was in the harsh winter of 2003-04, when we would expect high fawn mortality in both treatment and control areas. While these point estimates of over-winter adult and fawn survival were not statistically different between treatment and control areas, the long-term trends in these vital rates suggest deer in the treatment area may not be performing demographically as well as deer in the control area. Additionally, a portion of the deer normally wintering on the Mesa emigrated to a new, distinct winter range during the 2003-04 winter. The combination of changes in births, deaths, and emigration resulted in an estimated 46% reduction in deer abundance over four years, although we are unable to estimate the relative contribution of these factors to the decline. There is no evidence of a similar decline in abundance in the control area.

Possible management implications include:

- Monitoring shifts in distribution, or habitat use, or population parameters allows mitigation measures aimed at reducing impacts to be evaluated and timely, site-specific strategies to be developed. The current mitigation measure is focused on seasonal timing restrictions, where drilling activity is limited to non-winter months. This type of mitigation is common across federal lands and intended to reduce human activity and presumably the associated stress to big game during the winter months, typically 15 November to 30 April. Major shifts in the distribution of mule deer on the Mesa occurred during Years 1 through 3 of development even though drilling on federal lands was largely restricted to non-winter months. Estimates of deer abundance on the Mesa have significantly declined since development began. To date, our findings suggest seasonal timing restrictions may not be achieving desired results.

- In deep-gas fields like the PAPA where well densities range from 4 to 16 pads per section, the number of producing well pads and associated human activity may negate the potential effectiveness of timing restrictions on drilling activities as a means to reduce disturbance to wintering deer. Reducing disturbance to wintering mule deer may require restrictions or approaches that minimize the level of human activity during both production and development phases of wells. Directional drilling technology offers promising new methods for reducing surface disturbance and human activity. Limiting public access and road management strategies may also be a necessary part of mitigation plans.

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EXHIBIT C

Wyoming Greater Sage-Grouse Conservation Plan

Final Draft
May 27, 2003

EXHIBIT C

Table of Contents

Introduction

In the second half of the 20th Century, numbers of greater sage-grouse (*Centrocerucus urophasianus*), referred to as sage-grouse throughout this plan, have declined throughout their range. The causes of the decline have not been quantified.

In 2000, the U.S. Fish and Wildlife Service (Service) designated the Upper Columbia populations (Washington State) of the western greater sage-grouse (*Centrocerucus urophasianus phaios*) as candidates for listing under the Endangered Species Act of 1973, as amended (Act), 16 U.S.C. 1531 *et seq.*, due to their limited distribution and population numbers. The candidate designation means that listing is warranted, but is precluded by higher priority actions. In March 2003, the Service determined that the western subspecies was not warranted for listing. In addition, the Gunnison sage-grouse *(C. minimus)*, a closely related sagebrush obligate in western Colorado and eastern Utah, has also been designated as a candidate for listing under the Act. On December 26, 2002, the Service published a notice of negative finding for a petition received on the Mono Basin population (CA/NV) of the greater sage-grouse, as the petitioner was not able to definitively identify a distinct population segment. The Service has received petitions to list the greater sage-grouse across its entire range. While no decisions have been made on these petitions, litigation is pending.

People involved in the sage-grouse issue have initiated conservation planning efforts focused on outlining what is required to sustain or perpetuate populations. Wyoming elected to create this comprehensive statewide document, with locally developed plans to follow. Parties involved in the initial statewide effort included: agricultural, industrial, governmental, environmental, hunting, and Native American tribal interests.

The Wyoming strategy focuses on implementation by local working groups. In the absence of plans developed at local levels, goals and tasks and Recommended Management Practices (RMPs) found in this plan should guide planning and management efforts.

Using the concepts of rangeland health as a management philosophy (National Academy of Sciences 1994) should lead to a more balanced rangeland ecosystem, including a mosaic of seral stages beneficial to the greater sage-grouse.

Purpose of the Plan: (In no priority order)

The purpose of the Wyoming Greater Sage-Grouse Conservation Plan will be to:

- establish the framework for local working groups to guide management efforts directed at halting long-term population declines
- maintain and improve sage-grouse habitats in Wyoming
- provide for coordinated management across jurisdictional or ownership boundaries
- develop the statewide support necessary to assure the survival of Wyoming's sage-grouse populations
- be dynamic and flexible enough to include new information and issues as well as results from current and future conservation efforts
- provide Wyoming-based management solutions to sage-grouse problems using Wyoming-based data and research to the extent practicable
- address the five listing factors as defined by the Endangered Species Act of 1973, as amended

Guiding Goals and Principles of the Plan: (In no priority order)

- increase the present abundance and distribution of sage-grouse in Wyoming
- halt sage-grouse population declines in Wyoming
- determine the primary causes of sage-grouse declines
- provide Recommended Management Practices aimed at productive and healthy sage-grouse populations
- promote management that results in diverse, productive, and healthy sagebrush habitats while recognizing that sagebrush habitats provide values for species other than sage-grouse
- promote public involvement in planning and decision-making
- provide a framework for the development and implementation of local sage-grouse conservation plans to address and rectify potential impacts
- maintain an atmosphere of cooperation, participation, and commitment among wildlife managers, landowners, land managers, other stakeholders and interested public in development and implementation of conservation actions
- respect individual views and values, and implement conservation actions in a cooperative manner that generates broad community support
- implement conservation actions in a manner that meets the needs of sage-grouse, and are least disruptive to a stable and diverse economic base in Wyoming
- recognize the need to continually update data and apply them to local situations
- monitoring and evaluation are an important part of this plan, and adjustments to the goals, objectives, and conservation actions will be made considering the best available data
- identify research needs where knowledge is lacking
- encourage long-term funding for collecting and analyzing data over a period of time adequate to make appropriate resource management decisions

Plan Implementation

The statewide plan is largely reliant on implementation by local working groups. The role of the local working groups is to adapt the statewide plan to specific local areas and develop and implement strategies that will improve or maintain sage-grouse populations and habitats. In the absence of a completed local sage-grouse plan we encourage applicable state and federal agencies to use the information provided in the statewide plan as sage-grouse management guidance.

The statewide plan offers an overview of issues affecting sage-grouse in Wyoming and provides recommendations to address those issues. This plan is organized to facilitate the identification of issues that potentially impact sage-grouse populations on a local scale, and identify what steps should be taken to minimize those impacts. The plan has been developed using the most current information available. We encourage further investigation, but caution against "reinventing the wheel." Local working groups should not try to rewrite the statewide plan, but should focus on site-specific implementation to meet the goals outlined in this plan.

Statewide recommendations will need to be adapted to fit local conditions. While this will require development of an implementation plan, efforts should be focused on getting things done on the ground. Local working groups should evaluate potential limiting factors and develop strategies to address those factors. Groups should utilize resource specialists from all appropriate disciplines to develop and implement on the ground conservation actions. The Wyoming Game and Fish Commission (WGFC) should enter into agreements with federal agencies to implement this plan, and to address the needs of sage-grouse in all land use plans. Implementation of strategies will be done within the scope of agencies' existing policies, although local groups may influence agency policy, they do not have the authority to change agency policies, many of which are mandated by state and federal law.

Local working groups are in the best position to respond to these issues and will be essential to conservation of sage-grouse in Wyoming. Successful implementation will require the establishment of local working groups within a meaningful timeframe. Decisions are being made today relative to sage-grouse in Wyoming. One of the priorities is to identify populations at high risk and rank them according to need and potential for success. Consequently, local working groups should be established as soon as possible in high priority areas to allow citizen participation in the process. This may require commitment of resources from the State above and beyond what is currently available to the Wyoming Game and Fish Commission (WGFC). The general public, especially Wyoming citizens, have a role in sage-grouse conservation. Funding for sage-grouse conservation should not be limited to revenue from hunters, anglers and other traditional funding sources. Wyoming has access to federal Shrub-Steppe Restoration funding that could be used to initiate planning efforts. In addition, other state and federal land management agencies are allocating resources to sage-grouse conservation, and grant funding is becoming available nationwide.

Local Working Group Structure

- local working groups (groups) should be comprised of an equal number of knowledgeable individuals from four areas - agriculture, conservation, industry, and agencies, with single representatives from local government, tribes, public at large, etc. (No more than 12 individuals should comprise a group.)
- the Wyoming Game and Fish Department (WGFD) through the WGFC should call for participation in local areas and appoint local working group members who are credible representatives from the above four areas
- members should live or work in the area affected
- groups should utilize resource specialists from all appropriate disciplines
- groups should be facilitated with an identified administrator to take minutes and coordinate meetings
- after the 2nd meeting groups should elect a chair, to make sure tasks are completed,
- groups should establish a decision-making process, (consensus, majority, etc.) as well as timelines for accomplishing tasks
- these should be field-oriented, on-the-ground groups
- adequate advance meeting notice is essential and participation should be available to the public (e.g. WGFD website, and other appropriate sites)
- members of the statewide working group should be viewed as a resource to local working groups
- local groups should identify information gaps and research needs that exist within their area

Local Working Group Expectations

Within two years, Local Working Groups are expected to:

- identify and prioritize issues affecting sage-grouse in their area
- identify solutions to problems affecting sage-grouse in their area
- develop an action plan geared toward addressing these problems
- identify priority areas for implementation of conservation actions
- identify funding sources to implement conservation actions
- recommend to private, State or Federal land managers at least one project
- provide annual updates of progress to the Wyoming Game and Fish Commission and other affected agencies

The statewide working group recommends eleven local working groups as shown in Figure 1. Within one year of approval of this plan, local working group(s) should be formed in Upper Green River Basin, Powder River Basin, and Bates Hole/Shirley Basin to address local sage-grouse conservation plans. Within two years, additional groups should be added in Great Divide Basin, Wind River/Sweetwater River Basin, Lower Green River Basin, and Southwest. Within three years groups, should be added in Upper North Platte, Bighorn Basin, Jackson Hole, and Cheyenne River. Within two years of the formation of each local group, goals and tasks as outlined in the statewide plan should be acted upon.

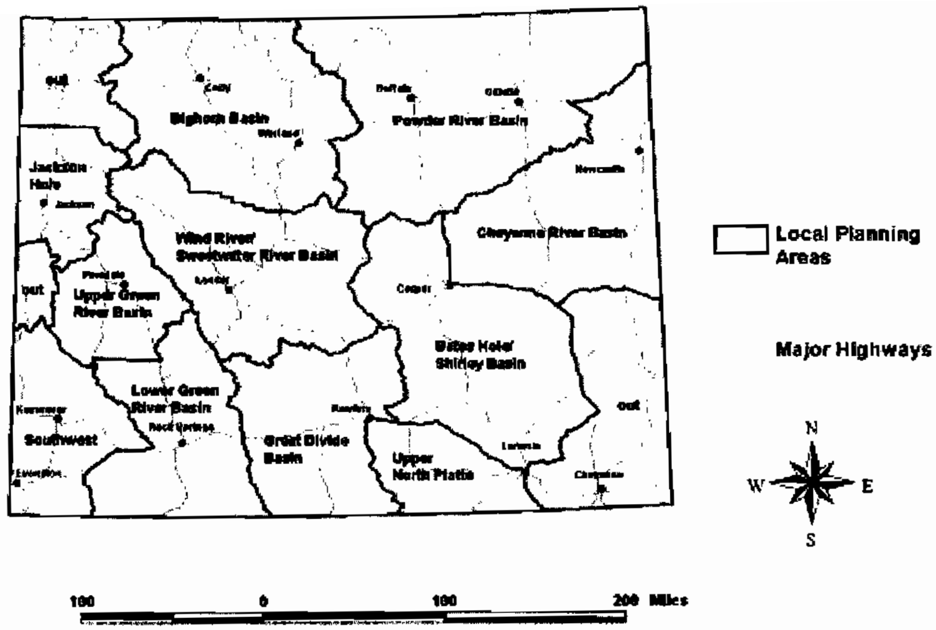

Figure 1. Local conservation planning areas for sage-grouse.

The following tasks (many of which are RMP's in this plan) are largely beyond the scope of Local Working Groups. The WGFD, in coordination with the BLM, Forest Service and other resource agencies/institutions as appropriate, should address these tasks within three years of the adoption of the statewide plan.

1) Continue to refine and implement sage-grouse population monitoring protocols that will more accurately document long-term population trends.
2) Prepare local and statewide annual reports of sage-grouse data utilizing the WGFD Sage-Grouse Database that includes status of known leks, hunter harvest and productivity data based on wings from harvested birds. These reports should include three and ten year trends (longer term where available).
3) Identify and map seasonal sage-grouse habitats (winter, breeding, nesting, early/late brood-rearing) statewide.
4) Develop and implement sage-grouse habitat monitoring protocols at both broad- and mid-scale (as defined in the plan).
5) Maintain or increase current levels of research on sage-grouse and their habitat (using the list of research needs provided in the plan).
6) Provide educational materials to the public-at-large and to specific groups as appropriate (e.g. recreationists, developers, landowners, hunters) about sage-grouse and their habitat needs. The first such document should be a Wyoming guide to enhancing sage-grouse habitat directed toward landowners/lessees who graze livestock."

Goals and Recommended Management Practices Defined

Goals describe desired results of Recommended Management Practices, and monitoring determines if goals are being met. Goals should be designed to be attainable, measurable, and based upon an appropriate timeline. Local sage-grouse working groups should develop site-specific objectives, which are consistent with the statewide goals outlined in this conservation plan. Statewide conservation plan goals are consistent with the intent and goals outlined in the MOU among the Western Association of Fish and Wildlife Agencies, U.S. Department of Agriculture (Forest Service), U.S. Department of Interior (BLM), and the U.S. Fish and Wildlife Service. The most current information available was used to develop statewide goals.

A Sage-Grouse Recommended Management Practice (RMP) is a management practice that should contribute to the maintenance or improvement of sage-grouse populations, or enhance the ecological health of Wyoming's sage-grouse habitats. RMPs are designed to be a "tool-box" of options local sage-grouse working groups and others can refine and use to address issues that have the potential to influence sage-grouse populations or habitats. Recommended Management Practices should be implemented based upon need. Highly impacted habitats and populations may require multiple tools or the whole "tool-box," while stable habitats and populations may only require a few maintenance tools. RMPs are intended to focus management strategies to help reach the goals outlined in local Wyoming Sage-Grouse Conservation Plan(s).

RMPs should be implemented when a population is trending downward, or is below the population indicated by 2000 lek data (see Population Status and Trend), or when local sage-grouse working groups, based upon the best available science, determine those RMPs are necessary to maintain local sage-grouse populations or habitat. Long- and short-term population thresholds of concern occur when lek counts indicate a population has declined by at least 10 percent over a 10 year period, or when lek counts demonstrate that a population has declined for three consecutive years with a cumulative decline of 10 percent. Long-term data generally consists of 10 or more years and shows the effects of habitat quality and management over time that may require long-term changes to land/resource use patterns. Short-term data should consist of no less than 3 consecutive years and may reveal the effects of more ephemeral issues such as drought that may require short-term changes in land/resource use patterns. Before implementing RMPs that alter existing management practices, limiting factors of the declining population should be assessed. This may include evaluating existing data or initiating detailed monitoring. RMPs should be selected to address the limiting factor(s) causing the decline. Monitoring should continue after RMPs are implemented to determine if goals are being achieved. Implementation of RMPs that substantially alter existing management strategies should be subject to local review by all affected interests.

The Statewide Sage-Grouse Working Group identified issues that could potentially affect sage-grouse populations and RMPs that could be used to address the identified issues. These goals and RMPs are divided into habitat based and activity based

sections. Duplication may occur. Repetition does not imply greater importance. Local working groups may identify additional issues.

When selecting RMPs the following fundamentals should be considered:

- apply most current and pertinent research to determine which management practices are contributing to negative trends in local sage-grouse populations and their seasonal habitats, and adjust management as information emerges
- RMPs selected should be directed to the factor(s) identified as causing the impact to or limiting the population (e.g. if a lack of forbs is identified as limiting chick survival the RMP should be directed to enhancing the production of food forbs)
- management decisions should be based on applicable studies, local conditions, and the potential of the range sites
- proposed changes to current planning documents or existing on-the-ground management for the purpose of enhancing sage-grouse should include an economic analysis of both the positive and negative impacts to existing users

Sage-Grouse and Their Habitats

Sage-Grouse Population Status and Trends in Wyoming

Sage-grouse are a large upland game bird considered a "landscape species", annually using widespread areas of sagebrush habitats. Sage-grouse are common throughout Wyoming because sage-grouse habitat remains relatively intact compared to other states. Figure 2 shows current and historical sage-grouse distribution in Wyoming.

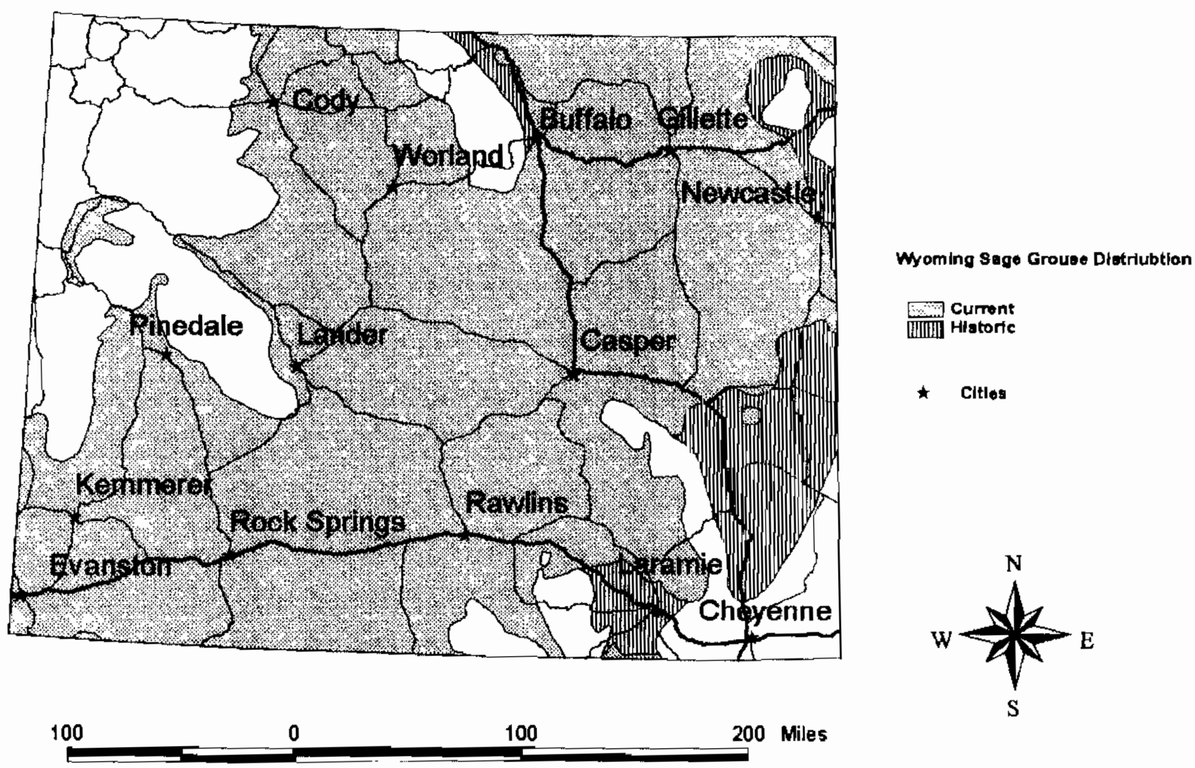

Figure 2. Wyoming greater sage-grouse distribution.

Available data sets and anecdotal accounts indicate declines in Wyoming sage-grouse populations over the last five decades.

Wyoming's first systematic report of sage-grouse leks began in 1949 with Robert Patterson's (1952) pioneering study, "The Sage Grouse in Wyoming". This study was largely conducted in northern Sweetwater County near Farson. Patterson counted 42 leks and observed 3,118 males in 1949 (average 74/lek) and 3,199 in 1950 (average 76/lek). By the 1990's, 39 of the 42 leks had been abandoned and are now considered historical. Six leks not identified by Patterson have since been documented. There were a maximum of 548 males on the 9 active leks in the study area in the 1990's (average 61/lek).

Efforts to monitor leks increased over the last half of the 20th Century to the point that in 2002, 1,164 leks were checked across Wyoming and 375 of these were viewed at least three times and are considered "count" leks. The remaining 789 are considered "survey" leks where activity or lack of activity was monitored. The number of checked leks equals the sum of counted leks plus surveyed leks.

While the effort to monitor leks has increased along with the total number of males counted, the number of males counted per lek has declined each decade since 1949 (Table 1, Figures 3 and 4).

Table 1. Wyoming statewide lek data by decade, 1949-2000. Based on February 2003 WGFD Sage-Grouse Database.

Years	# lek checks	# males observed	males/ lek	# lek counts	# males observed	males/ lek
1949-60	287	13,210	46	151	10,865	72
1961-70	814	25,119	31	142	6,726	47
1971-80	1,752	30,977	18	184	5,536	30
1981-90	5,302	80,609	15	430	10,005	23
1991-2000	7,838	97,438	12	1,956	41,874	21

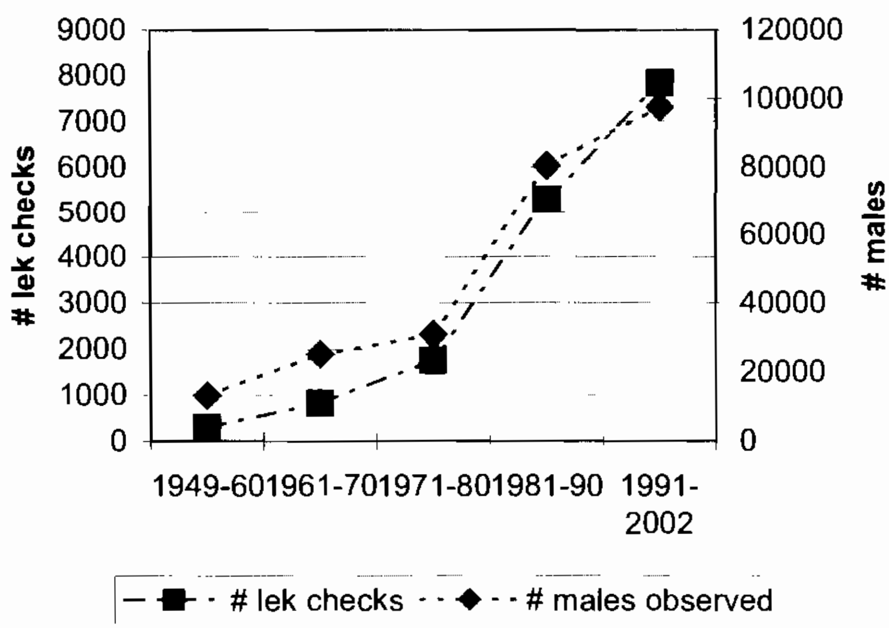

Figure 3. Wyoming lek observations by decade total.

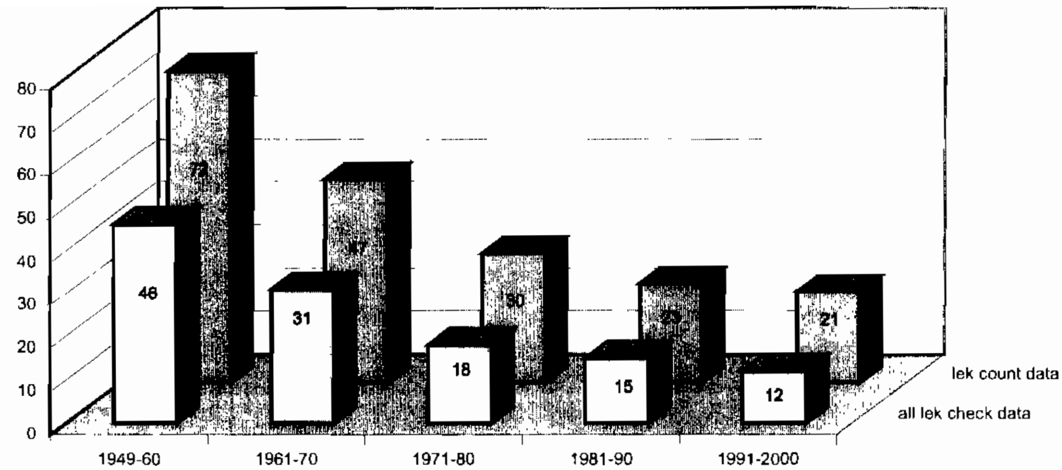

Figure 4. Wyoming statewide male sage-grouse per lek by decade average for lek counts and all lek checks.

Lek data must be interpreted with caution for several reasons: 1) the survey effort and the number of leks surveyed/counted has varied over time, 2) it is assumed that not all leks in the state have been located, 3) sage-grouse populations often cycle over approximately a 10 year period, 4) the effects of unlocated or unmonitored leks that have become inactive cannot be quantified or qualified, and 5) lek locations may change over time. Both the number of leks and the number of males attending these leks must be quantified in order to estimate population size. Monitoring male attendance on leks provides a reasonable index of relative change in abundance in response to prevailing environmental conditions over time.

Long-term harvest trends are similar to that of spring counts of males on leks. Hunting season regulations have varied over time, potentially changing total harvest irrespective of the grouse population trend, therefore the number of birds harvested per day per hunter statistic may provide a more consistent measure of relative bird availability, and therefore, abundance (Figure 5). The number of birds harvested per day declined approximately 50 percent between the 1960's and 1990's from an average of about two birds per day per hunter in the 1960's to about 1 bird per day in the 1990's. The rate of decline is very similar to that reflected in the lek data. Over most of this time the bag limit was consistently 3 birds per day.

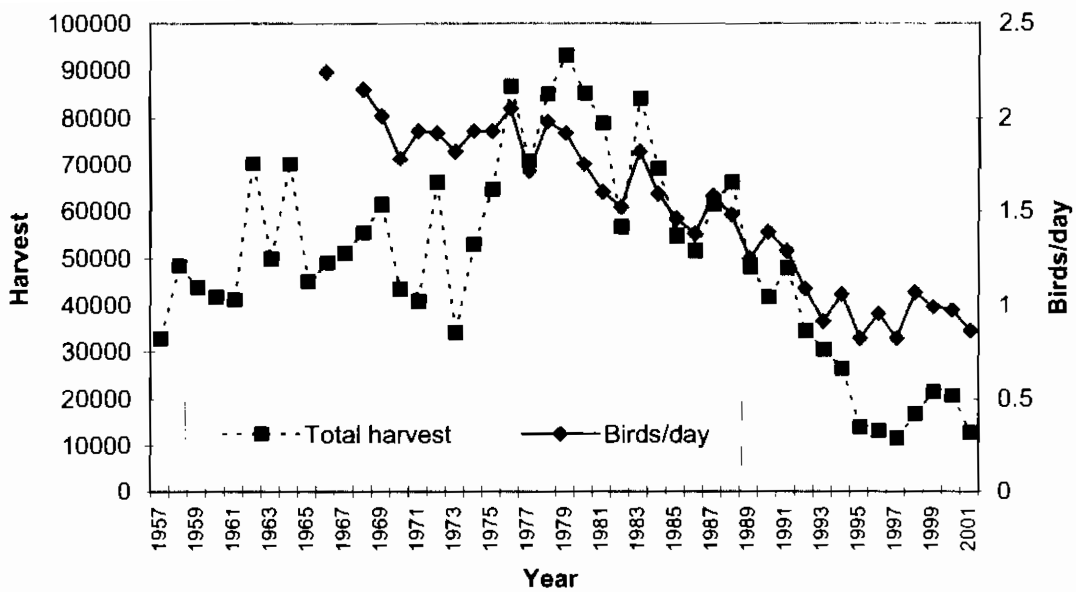

Figure 5. Wyoming statewide total sage-grouse harvest and birds/day 1957-2001.

One of the primary components of an effective sage-grouse conservation strategy will be the continued development of a standardized population monitoring program capable of producing meaningful, rigorous status and trend information. This monitoring program should result in regular reports being generated by the WGFD that can be used by local planning groups to analyze local situations and implement local conservation plans. These data should also be suitable for aggregate analysis at the statewide level.

With the exception of a few areas in the state where lek counts were conducted, lek monitoring during the latter half of the 20th Century was done primarily to document the presence/absence of leks. Because of the sheer number of leks in the state, the data were not collected systematically enough to provide meaningful population size information. Beginning about 1996, efforts were begun to collect more rigorous count information on specified leks so that population trends could be more precisely determined. Based on this information it appears that the statewide sage-grouse population was at very low levels in the mid 1990s but increased approximately three-fold during the late 1990's, peaking in 2000 (Figure 6). This increase was attributed to increased precipitation received in those years. While 2000's population increase was short-lived due to the return of drought conditions and was undoubtedly lower than that of the early 1950s, it does represent a baseline year for when the statewide population was relatively healthy.

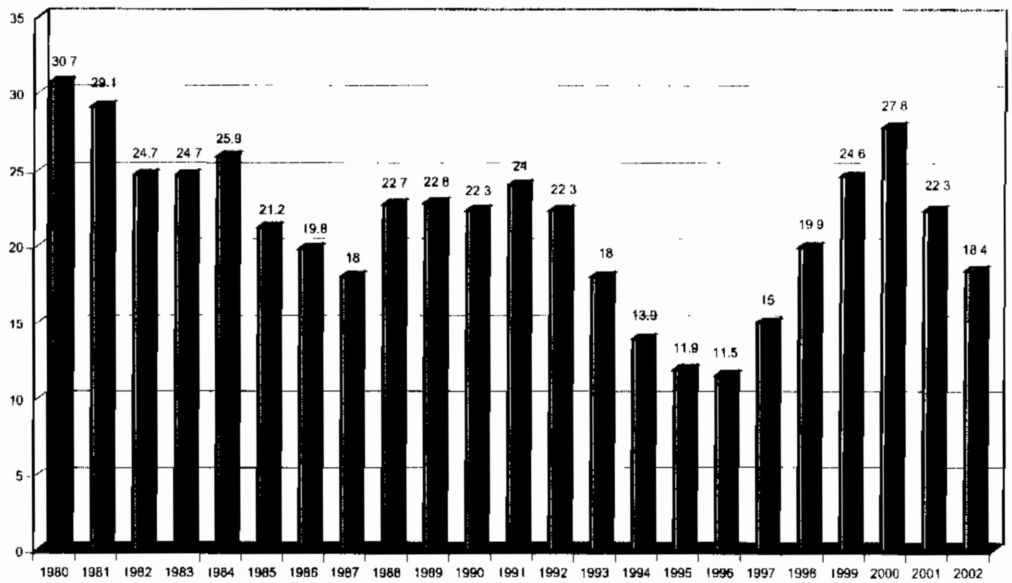

Figure 6. Wyoming statewide average males/lek 1980-2002.

For purposes of this statewide plan, the relative population level indicated by the lek count data from the year 2000 serves as a statewide objective to achieve during population peaks. The 295 leks that were counted in the state in 2002 had a peak count average of 28 males per lek. During the mid-1990's low point, there were not enough leks being counted to provide a reliable low point below which the population should not be allowed to reach. For purposes of this plan we recommend the average number of males on count leks not decline below 10 males per lek during population cyclic lows. The number of known active leks in 2002 (1,650-1,700) is the minimum number of leks the state should seek to maintain. It is assumed that a majority, but not all leks have been identified. This goal is subject to change dependent on the receipt of new information.

Since 1992, WGFD has expanded its effort to monitor and evaluate sage-grouse populations through increased funding for research and a renewed emphasis on obtaining lek counts and harvest information. Management costs borne by WGFD since 1990 are shown in Figure 7. Other agencies (e.g. BLM, Forest Service, Fish and Wildlife Service), private industry, and volunteers have also expanded efforts to conserve sage-grouse in Wyoming through research funding, monitoring, and mapping efforts. Several studies have been conducted, the results of which were utilized in the development of this document. In addition, a WGFD internal sage-grouse working group has been formed to encourage consistent data collection across the state and provide research and management recommendations. A statewide sage-grouse database has recently been developed that incorporates lek survey and count data as well as harvest data, including age and sex of harvest as determined by wing barrels. As this database comes into use, it should provide the basis for both local and statewide analysis of sage-grouse population status and trend. Additional efforts are being made across the species range to standardize population monitoring techniques.

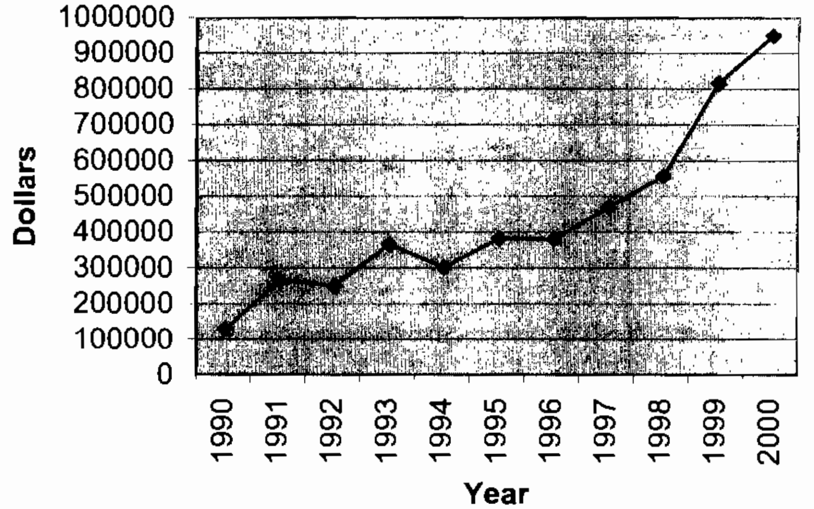

Figure 7. WGFD annual sage-grouse management expenditures 1990-2000.

Sage-Grouse Population and Population Monitoring Goals

1) Maintain or increase cyclical peak sage-grouse numbers as measured by a consistently applied monitoring protocol using data from the year 2000 as a baseline (28 males/count lek).
2) Do not allow the average number of males/count lek to decline below 10 during cyclical lows.
3) Maintain or increase active sage-grouse leks at or above the number of known leks in 2002 (1,650-1,700).
4) Provide for the long-term and short-term monitoring of sage-grouse in Wyoming.
5) Reflect as accurately as possible the historic distribution and status of sage-grouse.
6) Continue to implement established protocols for future population monitoring and record keeping, including mechanisms to insure consistent implementation.

Sage-Grouse Population Monitoring Recommended Management Practices

1) Prepare local and statewide annual summaries of sage-grouse data utilizing the primary database that includes information on the location and status of all known leks, hunter harvest and wing data.
2) Develop a monitoring protocol that would more accurately document long-term population trends.
3) Develop and refine techniques to measure productivity where wing data are unavailable.
4) Review population data annually to determine three and ten year trends.

Sage-Grouse Habitats

Sagebrush and sagebrush habitats are essential for sage-grouse survival. Suitable habitat consists of plant communities dominated by sagebrush and a diverse native grass and forb (flowering herbaceous plants) understory. The composition of shrubs, grass and forb varies with the subspecies of sagebrush, the condition of the habitat at any given location, and range site potential. Seasonal habitats must occur in a patchwork or mosaic across the landscape. Their spatial arrangement, the amount of each seasonal habitat, and the vegetative condition determine the landscape's potential for sage-grouse. This arrangement is an important factor in determining if a population is migratory or non-migratory in nature. Both quantity and quality of the sagebrush environment determines suitability for and productivity of sage-grouse.

Winter Habitat

During winter, sage-grouse feed almost exclusively on sagebrush leaves and buds. Suitable winter habitat requires sagebrush above snow. Sage-grouse tend to select wintering sites where sagebrush is 10-14 inches above the snow. Sagebrush canopy covers utilized by sage-grouse above the snow may range from 10 to 30 percent. Sage-grouse generally return to traditional wintering areas before heavy snowfall. Movements to wintering areas vary widely ranging from a few miles to over 50 miles, depending on the area. Foraging areas tend to be gentle southwest facing slopes and windswept ridges. Sage-grouse roost in open, low sagebrush sites on clear, calm nights. During windy periods or during snowstorms sage-grouse seek taller shrubs with greater canopy cover. Sage-grouse will fly considerable distances (>5 miles) and elevations (>1,000 feet) between winter feeding sites and suitable snow roosting sites. Sage-grouse will burrow in deep powdery snow to conserve energy. During severe winters, the amount of suitable available habitat is greatly reduced. Severe winter habitat may, or may not be, considered crucial habitat. Some severe winter habitat may be essential and used to a great extent during severe winters, while others may only be used occasionally.

Winter Habitat Goal

1) Maintain winter habitats in a manner that results in sustained or improved health with no long-term net loss of severe winter habitat.

Winter Habitat Recommended Management Practices

1) Use aerial photos, surveys, other remote sensing techniques, local knowledge and anecdotal information to identify winter habitat.
2) Map winter habitat by vegetation type, range site, and seral stages.
3) Manage winter habitat for robust annual growth of leaves and leaders on sagebrush.
4) When planning sagebrush altering activities, consider winter habitat needs on a landscape scale.

5) Integrate knowledge of wintering habitat with planning and management activities that will affect sagebrush habitats.

Breeding Habitat (Leks) - Early Spring

Breeding occurs on strutting grounds (leks) during late March and April. Leks are generally situated on sites with minimal sagebrush, broad ridge tops, grassy openings, and disturbed sites such as burns, abandoned well locations, airstrips or roads. Sage-grouse select spots with lower herbaceous height and less shrub cover than surrounding areas as lek sites. Leks are generally proximal to nesting habitat.

There are migratory and non-migratory populations of sage-grouse. In some areas both migratory and non-migratory birds may use the same lek. If all of the components of their habitat are available within one area, some sage-grouse may not migrate. For these non-migratory populations the lek may be an approximate center of their annual range. Migratory sage-grouse populations may move seasonally through hundreds of square miles of widely distributed habitats. There is evidence that sage-grouse hens exhibit fidelity to lek and nesting areas, and males return to leks where they have achieved stature in the breeding hierarchy.

As populations decrease, leks can be abandoned; however as populations increase and expand, leks can become active again.

Lek-Associated Habitat

Stands of sagebrush surrounding leks are used extensively by sage-grouse. During breeding, sage-grouse use the habitat surrounding a lek for foraging, loafing and protection from weather and predators. Pre-nesting habitats should contain areas of early-to-mid seral stage vegetative communities at fine scales with relatively open sagebrush canopies and a robust, leafy forb understory. These areas should be interspersed throughout potential nesting habitats. A small-grained mosaic of early-to-late seral stages of sagebrush communities is desired.

Plant composition in early spring habitat contributes to nesting success. At green-up, forbs are more nutritious than sagebrush. Sage-grouse hens need these protein, calcium, and phosphorus rich foods to support nest initiation, increase clutch size, and improve hatch success as well as early chick survival. Low growing leafy forbs, especially milky-stemmed composites (e.g. dandelion), represent potential food forbs. Commonly identified important food forb species include common dandelion (*Taraxacum officinale*), curlycup gumweed (*Grindelia squarrosa*), western salsify (*Tragopogon dubius*), western yarrow (*Achillea lanulosa*), prickly lettuce (*Lactuca serriola*), cudweed (*Gnaphalium palustre*), fleabane (*Erigeron* spp.), sweetclover (*Melilotus officinalis*), milkvetch (*Astragalus bisulcatus*), alfalfa (*Medicago sativa*), winterfat (*Eurotia lanata*) and fringed sagewort (*Artemisia frigida*) although most forb species when they are young and succulent are eaten by sage-grouse.

Breeding Habitat Goal

1) Maintain breeding habitat in a manner that provides adequate protein, calcium and phosphorus rich foods, especially forbs to support nest initiation, clutch size hatching success and chick survival that will maintain robust populations and increase depressed populations.

Breeding Habitat Recommended Management Practices

1) Limit the distribution of lek site information to avoid stressing birds. Avoid disturbance on lek sites while birds are on the lek, generally from March through May.
2) Identify and map lek and lek associated habitats.
3) Maintain areas of low sagebrush canopy cover and high herbaceous composition adjacent to nesting habitat.
4) Avoid habitat alteration on or within ¼ mile of the perimeter of lek sites.

Nesting Habitat - Late Spring

Approximately two-thirds of hens nest within 3 miles of the lek where they were bred. The remainder of the birds usually nest within 15 miles of the lek, but one collared bird in western Wyoming ranged 60 miles.

Sage-grouse typically nest under sagebrush, but may use other large shrubs. Sage-grouse select mid-height, denser sagebrush stands for nesting. Studies conducted in southern and southwestern Wyoming indicate that the nest bush heights (*Aretemisia tridentata wyomingenisis*) ranged between 8 to 18 inches for sage-grouse, but individual plants (all subspecies of *Artemisia tridentata*) utilized rangewide by sage-grouse may reach 32 inches in height. Sagebrush canopy cover at nesting sites ranged between 6% and 40%. Wyoming studies indicate greater total shrub and dead sagebrush canopy cover, and residual grass cover are vegetative attributes sage-grouse choose in the nest selection process, when compared to surrounding vegetation. These sagebrush stands should have sagebrush of varying heights with good residual grass under the sagebrush canopy, and the areas between the sagebrush should have good forb cover while maintaining some grass and litter cover. Live grass heights measured immediately after hatch ranged between 4 and 9 inches with residual grass heights of 2 to 6 inches. Herbaceous cover was quite variable and ranged between 1% and 85%. Although dead sagebrush canopy cover has been shown to be statistically significant in nest selection, it represented only 12% to 21% of the overall canopy cover in the stand. Dead sagebrush may provide screening cover while allowing for increased amounts of herbaceous understory.

In general, at nest sites, dense residual grasses at least as tall as the bottom of the canopy on mid-height sagebrush plants appear to positively influence hatching success. Areas that support a diverse forb understory should be in close proximity to these nesting sites for feeding during incubation and brood-rearing. Hatching success

appears to improve with increased forb cover. The vegetative composition of an area depends upon site potential, seral stage and past management.

Nesting Habitat Goal

1) Maintain nesting habitat in a manner that provides adequate sagebrush, residual grass and forb cover in order to maintain robust populations and increase depressed populations of sage-grouse.

Nesting Habitat Recommended Management Practices

1) Any activity that removes sagebrush should leave adequate areas for nesting sage-grouse in occupied sage-grouse habitat. Areas with sagebrush canopy cover exceeding 30% should be evaluated for treatment.
2) Where understory is limiting, vegetation manipulations should be considered to restore the grass and forb component in sagebrush stands to meet the needs of nesting sage-grouse.
3) Monitor nesting habitat to determine limitations on nesting suitability and success.
4) Manage for forb abundance and diversity to benefit hen nutrition.
5) Under sagebrush plants suitable for nesting, allow grass to achieve its annual growth potential. The percentage of nesting habitat existing in this condition should be determined on a site-specific basis.
6) Manage interstitial areas between sagebrush in nesting habitat to enhance food forbs.

Early Brood-Rearing Habitat - June to Mid-July

Early brood-rearing habitats are used during the brood's first month of life. Hens move their brood immediately upon hatching from the nest site to brood-rearing areas. Sites used during the first 10-14 days after hatching are typically within 1 1/2 miles of the nest. The vast majority of chick mortality (87% of total brood loss in four studies occurring in Wyoming) occurs during this period. After the first 10 days, broods may have dispersed five or more miles from the nest.

A highly diverse vegetation mosaic is essential to early brood-rearing. Early brood-rearing habitat is more open (10-15% sagebrush canopy cover and similar sagebrush height) with higher herbaceous cover than nesting habitat. Brood survival is tied to an abundance of insects and green vegetation, primarily forbs, in close proximity to sagebrush cover that provides adequate protection from weather and predators. Food forb species important to chick survival are very similar to those listed as important for pre-laying hens. Vegetation diversity increases insect diversity. Insects are crucial during the first ten days post-hatch. Studies suggest insects can make up to 75% of chick diets. Insects remain an important source of protein throughout the summer.

Early Brood-rearing Habitat Goal

1) Maintain early brood-rearing habitat near nest sites in a manner that provides adequate areas with less sagebrush cover, higher herbaceous cover (especially forbs) and greater insect abundance and diversity as compared to nest sites.

Early Brood-rearing Habitat Recommended Management Practices

1) Manage sagebrush understory and interstitial areas in early brood-rearing habitats to provide an abundance of forbs, insects and herbaceous cover.
2) Identify and monitor insect availability, abundance and diversity within specific sites to gain an understanding of their importance to sage-grouse.

Late Brood-Rearing Habitat - Mid-July through Mid-September

As summer progresses and food plants mature and dry, sage-grouse move to areas still supporting succulent herbaceous vegetation. They continue to rely on adjacent sagebrush for protection from weather and predators, and for roosting and loafing. These areas may be lower elevation native or irrigated meadows where uplands lack green vegetation. Sage-grouse will also migrate to higher elevations, seeking habitats where succulent forbs are still available in sagebrush habitats or select sites such as moist grassy areas, or upland meadows. A delay in maturing of forbs has a noticeable effect on bird movements. In years with above-normal summer precipitation, sage-grouse may find succulent forbs on upland sites all summer. In more arid areas, riparian meadows become more important to survival of broods in the late summer. From mid to late summer, wet meadows, springs and streams are the primary sites that produce the forbs and insects necessary for juvenile birds. The drier the summer, the more sage-grouse are attracted to the remaining green areas.

Late Brood-Rearing Habitat Goal

1) Maintain a mosaic of riparian habitats and wet meadows (including hay fields) that provide an abundance of green forbs near sagebrush cover.

Late Brood-rearing Habitat Recommended Management Practices

1) Manage riparian habitats, wetlands, springs and water sources in close proximity to sagebrush for food forbs and insects while maintaining the integrity of the riparian system.
2) Maintain sagebrush cover close to hay meadows or riparian areas.
3) Consider creating water overflow on developed water sources, and fencing spring sources and overflow areas to provide food forbs.

Fall Habitat - Mid-September to First Major Snow

Time spent in fall habitat is highly dependent upon weather conditions. Sage-grouse normally move off late brood-rearing habitat onto transitional fall habitat before moving onto winter range. As fall precipitation increases and temperatures decrease, sage-grouse move into mixed sagebrush-grassland habitats in moist upland and mid-slope draws where fall green-up of cool-season grasses and some forbs occur. As the meadows dry and frost kills forbs, sagebrush consumption increases. Fall movements to winter ranges are slow and meandering from late August to December. With major snowfall accumulation, sage-grouse move onto winter range.

Fall Habitat Goal

1) Maintain linkages of sagebrush habitats that allow birds to move between late brood-rearing and winter habitats.

Fall Habitat Recommended Management Practices

1) Avoid loss of fall habitat.

Landscape Context

Providing for all habitat needs on the scale required by sage-grouse may be the most challenging element of managing the landscape. The value of the various successional stages of sagebrush communities to sage-grouse is not well understood. Therefore there is debate about how they should be managed to maximize benefits to sage-grouse. There is also a need to identify structure and cover components. These challenges are greatest in breeding (pre-nesting, nesting and early brood-rearing) habitats. These habitats have to be in proximity to one another and constitute a small-grained mosaic of seral stages and vegetation structure (height and cover). All habitat types are important, and an overabundance of one type will not make up for a lack of another. For example, managing for a late-seral stage on a landscape scale will not necessarily provide for early brood-rearing habitat, and conversely managing for early seral sagebrush habitats on a large scale usually fails to provide the nesting and security cover needs of sage-grouse.

Because leks have been shown to be reliable indicators of nesting habitat, it is suggested that habitat assessment focus on nesting and early brood-rearing habitat associated with leks. Landscape scale is highly variable because the landscape may contain migratory or resident populations, or both.

It is assumed that, if upland vegetation is managed at a variety of early, mid, and late seral stages at the landscape scale, the area will provide sage-grouse with ~~a~~ the variety of habitats required annually. Issues relating to the landscape scale habitat needs of sage-grouse must consider seasonal habitat (pre-nesting, nesting, early brood-rearing, late brood-rearing, fall, and winter), juxtaposition, seral stages of vegetation, site

potential, vegetative structure, and past and future management. The ideal or required percentages of each seasonal habitat and the juxtaposition of these habitats on the landscape are not well known.

Landscape Habitat Goals

1) Maintain and enhance healthy sagebrush ecosystems, which provide a diversity of sagebrush seral stages and types (age, structure, cover classes, density) plant and animal species diversity, and patches of appropriate habitat, including riparian areas.
2) Maintain a healthy sagebrush understory with a diversity and abundance of forbs and grasses.
3) Maintain a healthy, diverse and abundant sage-grouse food source including insects.
4) Maintain seasonal habitats in amounts and proportions that provide for the needs of sage-grouse on a landscape scale.
5) Maintain a variety of human uses, including traditional and emerging uses, while providing for the needs of sage-grouse.
6) Maintain soil stability, watershed function, integrity of nutrient cycles and energy flow, and presence of recovery mechanisms.
7) Maintain landscapes in a vegetative mosaic that provides a variety of early, mid, and late seral stages.

Landscape Habitat Recommended Management Practices

1) Design and implement vegetation manipulations that benefit sagebrush ecosystems in the long-term with consideration for the needs of sage-grouse. (see Vegetation Management Section)
2) Manage for age class diversity and patchiness (within and between habitat types) in sagebrush habitats.
3) Treat noxious weeds and other invasive plants of concern aggressively where they threaten quality of sagebrush habitat.
4) Within three years, identify and map seasonal sage-grouse habitats statewide.

Conflicting Wildlife and Wild Horse Management

Management goals for other wildlife species utilizing sagebrush ecosystems can conflict with sage-grouse population and habitat management goals. Managing a single sagebrush site for all wildlife species that may inhabit sagebrush communities is impractical or not possible because practices that benefit some species can be detrimental to others. Approximately 100 bird species, 70 mammal species, and several reptiles are found in sagebrush habitats including many sagebrush obligates or near-obligates such as the sage-grouse, sage sparrow, Brewer's sparrow, sage thrasher, pygmy rabbit, sagebrush vole, sagebrush lizard, and pronghorn. A number of other priority or sensitive wildlife species are dependent upon or inhabit the sagebrush ecosystem including white-tailed prairie dog, ferruginous hawk, mountain plover, midget-faded rattlesnake, Columbian sharp-tailed grouse, and swift fox among others. Each has specific micro-site habitat requirements that often conflict with the seasonal habitat requirements of sage-grouse. On a landscape scale, with a mosaic of seral stages and vegetation types, the specific seasonal habitat requirements of the various wildlife species that inhabit sagebrush ecosystems can be accommodated.

Elk, mule deer and pronghorn are the primary wild ungulates that occur within occupied sage-grouse habitat. Grazing and browsing can contribute to long-term changes in plant communities and can alter various habitat components that contribute to the health of sagebrush ecosystems and the sage-grouse habitat it supports. As with livestock these grazing/browsing effects may be positive, negative or neutral depending on site specific conditions. Areas of concern may be where there is annual heavy sagebrush browsing by large winter concentrations of mule deer, pronghorn or where high densities of wild horses or wintering elk reduce residual grasses in nesting habitat.

Federal and state laws, rules and regulations have been enacted that limit management options for various wildlife or plants. Some may conflict with sage-grouse management goals. Some threatened, endangered or candidate species have habitat requirements or other needs that directly conflict with sage-grouse habitat requirements or preferences.

Conflicting Wildlife and Wild Horse Management Goal

1) Minimize negative impacts to sage-grouse caused by management practices and habitat improvement projects intended for other species.

Conflicting Wildlife and Wild Horse Management Recommended Management Practices

1) Evaluate effects to sage-grouse caused when managing for other wildlife species.
2) Evaluate effects wild horses have on sage-grouse.
3) Review federal Appropriate Management Levels (AML) for wild horses as they relate to habitat conditions for sage-grouse. Until such review is complete, maintain wild horse numbers no higher than AML.

4) Document areas where conflicting species management goals may negatively impact sage-grouse.
5) Assess how proposed habitat improvement projects geared toward other species could impact sage-grouse.
6) When planning mitigation projects, avoid negative impacts to sage-grouse.
7) Review big game herd goals and modify and implement special big game seasons to meet harvest objectives as necessary to improve habitat conditions for sage-grouse.
8) Incorporate sage-grouse needs into management plans for wildlife, especially big game.

Farming

In Wyoming, "farming" is primarily harvest of native hay in meadows along some streams and rivers and very limited row or cash crop farming. Farming areas are primarily in irrigated settings with the major crops being native hay, alfalfa, barley, oats, corn and some sugar beets. Farming areas (dry land and irrigated) make up only about 1.5 million acres of the state, or 2.5 percent of the land area and have remained at that level for many years. Most farmland is privately owned, and the value of habitat and open space provided by the continued existence of farm operations should be recognized.

Many of the impacts that occurred from farming occurred following homesteading of Wyoming. Sagebrush habitats that had the best soils were converted to hay and row crops. Today only limited areas are being converted from sagebrush habitats to farmlands that support hay and row crops. Farms that raise alfalfa or native hay may be beneficial to sage-grouse. Some degree of habitat fragmentation may occur as a result of farming and associated infrastructure. Ecological and economic constraints limit the amount of land in Wyoming that can be converted to farmland. Federal farm programs associated with dry land crops may lead to the conversion of sagebrush to farmland.

Farming Goal

1) Conduct farming operations in a manner that is compatible with maintenance and enhancement of sage-grouse habitat.

Farming Recommended Management Practices

1) Map suitable sage-grouse habitat and focus conservation and management efforts on areas where the most benefit can be realized.
2) Identify the types of agricultural practices that are beneficial or detrimental to sage-grouse.
3) Develop and provide information on funding options available to landowners who wish to improve sage-grouse habitat.
4) Work with private landowners to prepare habitat maps, which identify seasonal habitats for sage-grouse and to develop a voluntary site-specific management program.
5) Provide landowners with information on sage-grouse and how to provide for and protect sage-grouse habitat.
6) Develop water sources to benefit both crop production and healthy riparian habitat. Avoid surface and sub-surface water depletion that impacts sage-grouse habitats.
7) Improve visibility of new fences, and of existing fences where problems have been documented, in sage-grouse habitats.
8) Research and develop incentives that would reward farmers who provide the type of habitat that maintains and enhances sage-grouse populations.

Hunting

Sage-grouse hunting in Wyoming is a traditional recreation activity in modern times and was one means of human subsistence prehistorically. Sage-grouse have been hunted annually under regulation of the WGFD since 1948. From 1937 to 1947 the hunting season was closed because of concern over low populations of grouse. Native Americans traditionally hunt male sage-grouse in the spring. This practice continues at minimal levels on the Wind River Indian Reservation.

Sage-grouse hunting provides recreational, cultural and economic values. The biological data the harvested birds provide via harvest surveys and wing collections serve as important indicators of population status. In addition, hunting creates a constituency of sage-grouse advocates who are interested in seeing that grouse and their needs as a population are met. However, concern has been expressed about the impacts of recreational hunting to sage-grouse populations in Wyoming.

It appears that hunting harvest of adult hens may have a detrimental impact on population. For many years it was traditional in Wyoming to hunt sage-grouse in late August or early September. However, data indicates hunting at this time makes adult hens more susceptible to harvest, because hens with chicks are still concentrated on late brood-rearing habitats. Sage-grouse are relatively long lived with lower reproductive rates and lower annual turnover than other game birds. Adult female grouse are more successful hatching clutches and raising chicks than are yearling hens. Thus, maintaining a higher proportion of adult hens in the population allows the population to grow faster under favorable habitat conditions. In order to relieve harvest pressure on adult hens, hunting seasons have been moved to late-September when typically cooler, wetter weather, along with the fact that chicks are more independent, results in dispersal of these family groups. This dispersal makes adult hens less vulnerable to harvest since they are more scattered across their habitat and mixed with barren hens and males. Harvest rates of successfully nesting hens have declined since the hunting season dates were changed in 1995. Overall harvest declined as well due to a dramatic decrease in hunter participation since other hunting seasons, especially big game in western Wyoming, begin in mid-September.

Complete closure of hunting seasons has not been documented to result in subsequent increases in breeding populations. However, two areas in Wyoming have been closed to hunting, southeast Wyoming and northwest Wyoming. Sage-grouse habitat and numbers are limited in these areas and while Wyoming has chosen a conservative approach to hunting in these areas, it is not anticipated the closures will result in increasing populations.

Research to document the impact of closing hunting seasons on local bird populations is currently being conducted in Idaho. The results of these efforts should be evaluated prior to consideration of closing hunting seasons in Wyoming.

Hunting Goal

1) Conduct hunting of sage-grouse in a manner that is compatible with maintaining robust populations and allows depressed populations to increase.

Hunting Recommended Management Practices

1) In stable to increasing populations (based on lek count information) maintain a 2 to 4 week hunting season with a 3 bird daily bag limit beginning no earlier than September 15.
2) If populations are declining (for 3 or more consecutive years based on lek count information) implement more conservative regulations that might include: reduced bag limits, adjusted season dates, limited quota seasons or closed seasons.
3) Populations should not be hunted where less than 300 birds comprise the breeding populations. (i.e. less than 100 males are counted on leks)
4) Collect hunter harvest data via hunter surveys and wing barrels.
5) Inform and educate the public about hunting impacts and benefits.
6) Determine the effects of hunting on sage-grouse populations.

Invasive Plants

The extent to which invasive plants, primarily non-natives, have historically affected sage-grouse in Wyoming is unknown. However, there is potential for these undesirable plants to have a significant effect in the future if left uncontrolled. Invasive plants along roadways and right-of-ways can spread to surrounding rangelands and riparian areas and replace native vegetation critical for sage-grouse nesting and brood-rearing. Primary species of concern in sage-grouse habitats appear to be knapweed, leafy spurge, cheatgrass, and Japanese brome. In riparian areas this list may be more expansive.

Invasive Plants Goal

1) Reduce, control and prevent the introduction of invasive plants of concern in known sage-grouse habitat.

Invasive Plants Recommended Management Practices

1) Identify invasive plants of concern in sage-grouse habitats.
2) Map areas where invasive plants of concern already exist.
3) Implement strategies to assist in prevention of the spread of noxious weeds or invasive plants detrimental to sage-grouse.
4) Prioritize and aggressively treat invasive plants in identified areas of concern.
5) Employ appropriate site preparation techniques and timely reseeding with approved seed mixes of any disturbed areas to prevent encroachment of invasive plants.
6) Maintain cumulative records for invasive plants treatment and prevention programs to evaluate site specific and cumulative impacts to sage-grouse habitats.

Livestock Grazing

Domestic livestock grazing has been identified as a factor that may affect the suitability and extent of sage-grouse habitat across the western United States. Grazing and browsing can contribute to long-term changes in plant communities and can alter various habitat components that contribute to the health of sagebrush ecosystems and the sage-grouse habitat it supports.

Both positive and negative direct effects of livestock grazing on sage-grouse habitats have been identified. For example, short duration grazing in late spring and early summer has been reported to improve both quantity and quality of summer forage (forbs) for sage-grouse. Conversely, continuous heavy use by livestock and/or wild ungulates rarely leaves suitable residual cover for nesting or maintains the site potential for riparian areas in sage-grouse habitat. However, there have been few research efforts made, and therefore little direct experimental evidence, linking specific livestock grazing practices to sage-grouse population levels.

The sagebrush ecosystem evolved with grazing by a variety of wildlife species. The timing, duration, location, and intensity of that grazing is not quantified. The introduction of livestock grazing into the sagebrush landscape presented a shift from a mixture of migrating, free ranging wildlife grazers and browsers toward managed domestic sheep and cattle. Since that time, there have been changes over the landscape in terms of the location, class and season of use, grazing management systems, and total numbers of herbivores on the range, large and small, domestic and wild. A focus on "improving range condition", defined by public policy over the last 70 years as growing more grass, coupled with a shift from sheep to cattle also have affected sage-grouse habitats but these impacts are not well documented.

Active management aimed toward opening the canopy in decadent sagebrush stands and creating and maintaining a diversity of desirable micro-sites is beneficial to sage-grouse. Forb diversity and forb-associated insects are important to pre-nesting condition of hens and early brood-rearing of chicks. There is some evidence that there has been a reduction of these important habitat components as a result of current and historic grazing and fire management policies in some areas. The interaction between fire and grazing may be important to habitat diversity, but is not well understood.

A healthy sagebrush ecosystem provides the diverse age groups and vegetative seral stage classes necessary to sustain and increase sage-grouse populations while providing for other wildlife, and multiple uses of the area, including livestock grazing. Ecosystems that do not provide this diversity need long-term management strategies to allow recovery. Management changes should be analyzed so that those made on behalf of sage-grouse do not inadvertently cause unacceptable harm to other species.

Livestock Grazing Goal

1) Manage livestock grazing practices on state, federal and private lands in a manner that assists in maintaining healthy sage-grouse habitats or improving degraded habitats.

Livestock Grazing Recommended Management Practices

1) Encourage wildlife professionals, livestock producers and other interested parties to become more tolerant, understanding, and respectful of each other's perspective, and focus on areas of mutual interest.
2) Evaluate effects of different grazing treatments on sage-grouse productivity, survival, and habitat use.
3) Actively educate stakeholders about grazing strategies that can be used to improve or maintain sage-grouse habitats. Create and distribute a Wyoming guide to enhancing sage-grouse habitat.
4) In general, yearlong and spring-to-fall continuous grazing schemes in sage-grouse habitat should be avoided. Yearlong and spring-to-fall grazing may be a tool if it is not continued each year.
5) Where appropriate, implement livestock grazing systems that provide for areas and times of rest or deferment.
6) Avoid heavy utilization of grazed pastures to compensate for rested pastures (a year of rest cannot compensate for a year of excessive use).
7) Design grazing systems that provide sage-grouse habitat in riparian areas and around water sources.
8) During periods of forage drought utilize grazing schemes that reduce impacts to sage-grouse (e.g. adjust intensity, timing and/or duration of grazing).
9) Investigate the possibility of developing forage banks for use during periods of drought to alleviate inappropriate use by grazing animals on sage-grouse habitat.
10) Reduce disturbance to sage-grouse during the strutting period from livestock management activities (e.g. salting or mineral placement, turnout or gathering, bed ground/camp locations, etc.)
11) Develop and implement management plans for grazing that take into consideration the seasonal sage-grouse habitat needs. These management plans could include a variety of grazing systems designed to reach habitat goals, including short-duration, rest rotation, etc.
12) Look for ways to minimize negative impacts and enhance sage-grouse habitat when establishing livestock range improvement projects (e.g. water overflow for sage-grouse from water developments, placement of fences, facilities that provide raptor perch sites, construction of roads, salt grounds).
13) Avoid human activity near leks during the breeding season between the hours of 8 p.m. to 8 a.m.
14) Except for livestock guard dogs, avoid allowing dogs to run unchecked in sage-grouse habitats.
15) Experiment with types of grazing to improve sage-grouse habitat accompanied by monitoring to determine effects on sage-grouse.

16) Where necessary to build or maintain fences, evaluate whether increased visibility, alternate location, or different fence design will reduce hazards to flying grouse.

Mineral Development

Mineral and energy development impacts on sage-grouse have not been adequately quantified. The discovery and development of natural gas, oil, coal bed methane, coal, uranium, trona, bentonite, gypsum and construction materials throughout the western United States has impacted habitat and has been identified as a potential causative agent in declining sage-grouse populations. There is increasing demand for goods and services supported by the minerals industry. For example, according to the American Gas Association, natural gas consumption in the U.S. is expected to increase at least 40% by the year 2015, therefore impacts from these operations are expected to continue.

The various types of mineral operations are managed pursuant to a wide array of state and federal statutes and regulations, each with specific provisions that may or may not be flexible. No single set of RMPs for sage-grouse will work for all forms of mineral development, therefore, flexibility and a familiarity with the applicable and appropriate controlling regulations are necessary to adapt these operations to provide for the needs of the grouse. Local working groups must work with mineral development companies to devise appropriate local solutions. The selection and implementation of RMPs will also need to be approved by the surface management agency, and the state regulatory agency in order to be successful. RMPs have been divided into categories that may be considered for all mineral operations including those specific to oil and gas/coal bed methane, coal mining, other mining and sand and gravel operations.

Some potential impacts of mineral development to sage-grouse include: (1) direct habitat loss and fragmentation from mine, well, road, pipeline, transmission and power line construction, (2) alteration of plant and animal communities, (3) increased human activity which could cause animals to avoid the area, (4) increased noise which could cause animals to avoid an area or reduce their breeding efficiency, (5) increased motorized access by the public leading to legal and illegal harvest, (6) direct mortality associated with water evaporation ponds and production pits, and (7) reduced water tables resulting in the loss of herbaceous vegetation. Many of these impacts can be minimized by mitigation, reclamation, and planning for sage-grouse needs. Some of these impacts are short-term related to specific periods of activity, and some may result in positive effects such as increased forb production, habitat diversity and additional water sources. Impacts may be long-term (30 years or more), and rehabilitation of impacted habitats may take many years to complete.

Roads built to accommodate mineral exploration and development activities often result in the establishment of permanent travel routes, improved public access, increased long-term traffic related disturbance, indirect noise impacts, and direct mortality. Research suggests that road-related disturbances during the breeding season may cause sage-grouse leks to become inactive over time, reduce the number of hens bred on disturbed leks that initiate nests, and increases the distance from the lek hens will move to selected nesting habitat. Dust from roads and other surface disturbances can adversely affect plants and animals. Transmission and power line construction does not cause direct habitat loss, but sage-grouse tend to avoid areas associated with these

lines (as they provide potential raptor perch sites), thus resulting in an indirect loss of habitat in the vicinity of overhead lines. The potential effects of noise on sage-grouse include masking sounds that influence courtship, mate selection, grouping, escape, etc. Research into these subjects is on-going.

Mineral Development Goal

1) Develop the mineral resource in a manner compatible with maintenance and enhancement of sage-grouse populations and habitat.

General Mineral Development Recommended Management Practices

1) Evaluate and address the needs of sage-grouse when placing well sites, mines, pits and infrastructure. Develop a plan for roads, pipelines, etc. to minimize impacts to sage-grouse
2) Consider developing travel management plans that would allow seasonal closure of roads for all but permitted uses (i.e. recreation and hunting) and encourage the reclamation of unnecessary or redundant roads.
3) Where mineral development occurs in sage-grouse habitat, tailor reclamation to restore, replace or augment needed habitat types.
4) Where necessary to build or maintain fences, evaluate whether increased visibility, alternate location, or different fence design will reduce hazards to flying grouse.
5) Avoid construction of overhead lines and other perch sites in occupied sage-grouse habitat. Where these structures must be built, or presently exist, bury the lines, locate along existing utility corridors or modify the structures to prevent perching raptors, where possible.
6) Reduce noise from industrial development or traffic especially in breeding and brood-rearing habitats.
7) Manage water production to enhance or maintain sage-grouse habitat.
8) Avoid surface and sub-surface water depletion that impacts sage-grouse habitats.
9) Consider an exception or waiver of seasonal stipulations if technologies that significantly reduce surface disturbance are used.
10) Control dust from roads and other surface disturbances within the population's seasonal habitats.
11) Continue research efforts to determine the effects of mineral development on sage-grouse populations.
12) Consider off-site mitigation as an alternative mitigation for mineral development impacts on known sage-grouse habitat. Work with mineral entities to develop and implement acceptable offsite mitigative measures for enhancing sage-grouse or habitat, as needed, to offset impacts of surface disturbing activities

Oil and Gas Development and Sand and Gravel Mining (Also See General Mineral Development RMPs)

1) As a general rule, do not drill or permit new or expand existing sand and gravel activities within two miles of active leks between March 15 and July 15. As seasonal habitat mapping efforts are completed, re-direct efforts towards protecting nesting habitat.
2) Avoid surface disturbance or occupancy on or within 1/4 mile of known active lek sites.
3) Evaluate well spacing and location requirements under Wyoming Oil and Gas Conservation Commission jurisdiction in light of sage-grouse habitat needs and consider spacing exceptions that protect habitat. The limitations of obtaining spacing exceptions must be recognized.
4) Where sage-grouse are present or desired avoid human activity adjacent to leks during the breeding season between the hours of 8 p.m. and 8 a.m.
5) Where technically and economically feasible, use directional drilling or multiple wells from the same pad.
6) Where facilities are developed within sage-grouse habitat, minimize potential use by predators.
7) Encourage the development of new technologies that would reduce total surface disturbance within occupied sage-grouse habitat.

Other Solid Mineral Mining Operations (Also See General Mineral Development RMPs)

1) When feasible, new or expanded exploration and/or mining activities within two miles of active leks should occur prior to March 15th or after July 15th. Following initiation of mining (i.e. topsoil stripping) this recommendation would not be applied. As seasonal habitat mapping efforts are completed, re-direct efforts towards protecting nesting habitat.
2) When feasible, plan to avoid new surface occupancy or disturbance activities on or within 1/4 mile of the perimeter of known active a lek site from March 15 to July 15.
3) Where sage-grouse are present or desired, avoid human activity adjacent to leks during the breeding season between the hours of 8 p.m. and 8 a.m. This RMP may not be practical in active coal mining areas.

Parasites and Diseases

Sage-grouse are known to harbor a number of different parasites and diseases. Most diseases and parasites have evolved with sage-grouse over time. Many of these afflictions are often not a serious concern unless the sage-grouse are stressed. Diseases and parasites that affect sage-grouse include various bacteria, protozoa, worms and ecto-parasites. Many of the common parasites and diseases carried by sage-grouse appear to be non-pathogenic, but may increase the vulnerability of infected birds that are stressed or concentrated. Coccidiosis is one disease that has been identified as a cause of sage-grouse mortality. The potential effects of the newly emergent West Nile Virus are unknown at this time. Diseases and parasites may potentially become an issue if sage-grouse come into contact with captive raised birds released into the wild. In general, it is not believed that diseases and parasites are a major issue in sage-grouse declines.

Parasites and Disease Goal

1) Minimize impacts of parasites or disease on sage-grouse in Wyoming.

Parasites and Diseases Recommended Management Practices

1) Investigate and record deaths that could be attributed to parasites or disease.
2) Develop and implement strategies to deal with disease outbreaks where appropriate.

Pesticides

Pesticides (herbicides, insecticides and rodenticides) are used throughout the state for a variety of purposes and have been identified as a possible influence on sage-grouse. However, it is not believed that pesticides are currently a major issue for sage-grouse under existing application practices in Wyoming. No direct research on the effects of the field applications of currently used pesticides on sage-grouse has been conducted in Wyoming. Toxicity under laboratory conditions does not equate well to wildlife hazards under field conditions. Sage-grouse exposure and potential risk are dependent on numerous factors, such as application rate, pesticide formulation, and timing of treatment.

Pesticide impacts on sage-grouse in the field are difficult to quantify. This is exacerbated by the fact that these effects are believed to be sub lethal, such as predisposing animals to predation or reducing reproductive success. Elimination of insects, or reduction of forbs has been documented and may be locally significant, but not widespread. Loss of sagebrush to large-scale chemical treatments can eliminate sage-grouse habitat.

Pesticide Goals

1) Conduct pesticide application efforts in a manner that is compatible with sage-grouse health and habitat needs.
2) Encourage development of a statewide pesticide use database.

Pesticide Recommended Management Practices

1) Determine the extent of pesticide use within sage-grouse habitats.
2) Examine what, if any, effects each pesticide use may have on sage-grouse populations.
3) Where possible, adjust alfalfa harvest timing instead of applying pesticides to control weevils.
4) Make use of current laboratory analysis procedures where sage-grouse mortality is observed. Report where pesticides have caused mortality in sage-grouse.
5) Determine which pesticides and application strategies are simultaneously beneficial to agriculture and least harmful to sage-grouse.
6) Research effects of pesticides on sage-grouse in Wyoming with a specific goal of testing impacts of actual rangeland applications.
7) Work with county Weed and Pest Districts to identify low-toxicity alternatives to pesticides classified as a medium to very high risk to game birds.
8) Provide Wyoming retail dealers, Weed and Pest Districts, and county extension agents with information intended for users regarding product toxicity levels to sage-grouse, and alternatives that are effective while less toxic.
9) Encourage simple, standardized record-keeping formats for all Weed and Pest Districts, that would allow access to pesticide use information in their counties and statewide.
10) Address grasshopper issues using Reduced Area Application Treatments (RAATs) approach.

Predation

As should be expected, predation is and has always been the major cause of sage-grouse mortality. Predation during nesting and early brood-rearing has the greatest influence on sage-grouse populations. Nest predators identified in Wyoming studies include badgers, red foxes, ravens and ground squirrels. In addition, golden eagles, red foxes, ravens, coyotes, various hawks, bobcats, and weasels prey on sage-grouse throughout the year.

Humans have altered the landscape and influenced predator-prey relationships that evolved between sage-grouse and native predators. These activities have led to a change in the number, distribution and type of predators that prey on sage-grouse. As habitats are altered, and/or where predators dramatically increase in number or in type, impacts of predation may be magnified. "Newcomer" predators such as red fox and raccoons have expanded their range into sage-grouse habitats where they were not previously a factor. These newcomers and traditional sage-grouse predators have increased in numbers largely as a result of readily available food associated with human activities. Migratory bird protection has also allowed avian predator populations to expand.

Lethal predator control to increase production and recruitment in bird populations has only been shown to be effective on small, intensively managed areas where efforts are continual. Management of predators may be necessary in localized situations to maintain a sage-grouse population. Predator management may mean lethal control, but may also include removing key elements that attract predators (e.g. perches, food sources) and/or increasing the quality of habitat for sage-grouse.

As with many issues surrounding sage-grouse management, predator-prey relationships are complex and difficult to quantify. It is important to identify potential unintended consequences of predator control as it relates to sage-grouse. Large-scale predator removal is not indicated as a statewide objective. Where predation is demonstrated to be of significant concern, planning groups should consider localized predator management.

Predation Goals

1) Minimize the negative effects of predation in order to increase sage-grouse recruitment.
2) Maintain habitat quality that discourages predation.

Predation Recommended Management Practices

1) Local working groups should consider predator control to maintain or enhance local sage-grouse populations when they determine there is a demonstrated need such as a population is trending downward over a 3-year period; populations of "newcomer" predators are artificially high in sage-grouse habitat; specific sage-grouse populations need short-term help.

2) Develop and distribute educational materials regarding human practices that may allow establishment/expansion of predator populations. Examples of these activities include landfills and other garbage/waste disposal that may provide artificial food sources for a variety of predators, and buildings/structures that provide nesting/roosting habitat for ravens/raptors.
3) Avoid construction of overhead lines and other perch sites in occupied sage-grouse habitat. Where these structures must be built, or presently exist, bury the lines, locate along existing utility corridors or modify the structures in key areas.
4) Predator control to enhance sage-grouse survival should be targeted only to predators identified as impacting that sage-grouse population.
5) Better quantify and qualify the role of predation on sage-grouse in Wyoming.
6) Discourage the establishment, and bring into balance artificially high populations of "newcomer" predators in sage-grouse habitat.
7) Monitor the effectiveness of any predator control efforts that are implemented.
8) Request the U.S. Fish and Wildlife Service to do a species assessment on the raven. Encourage the FWS to include ravens in 50CFR21.43 "Control of Depredating Birds."

Recreation

Recreational impacts to sage-grouse populations include potential disturbance of breeding and nesting activities, and habitat fragmentation due to road usage. Research suggests that road-related disturbances during the breeding season may cause sage-grouse leks to become inactive over time, cause fewer hens bred on disturbed leks to initiate nests, and increases the distance from the lek hens will move to selected nesting habitat. Dust from roads and other surface disturbances can adversely affect plants and animals. Recreational viewing of leks can cause disruption of breeding activities, especially when it is conducted from too close a distance and/or on a long-term basis. The increased use of off-road vehicles and other outdoor recreational activities may result in greater disturbance of sage-grouse and degradation of habitats. These impacts are more likely to occur on public lands, or on leks adjacent to public roads.

Recreation Goals

1) Conduct recreational activities in a manner that is not disruptive to sage-grouse or their habitat.

Recreation Recommended Management Practices

1) Develop travel management plans and enforce existing plans.
2) Restrict off-road-vehicle use in occupied sage-grouse habitats
3) Avoid recreational activities in sage-grouse nesting habitat during the nesting season.
4) Restrict organized recreational activities between March 15 and July 15 within two miles of a lek site.
5) Recreational facilities should be located at least two miles from lek sites and in areas that are not in crucial sage-grouse habitat
6) Establish and maintain a small number of lek viewing sites and minimize viewing impacts on these sites. Viewing sage-grouse on leks (and censusing leks) should be conducted so that disturbance to birds is minimized or preferably eliminated.
7) Agencies should generally not provide all lek locations to individuals simply interested in viewing birds.
8) Develop and provide information related to recreation and its impacts on sage-grouse habitat.
9) Discourage dispersed camping within important riparian habitats occupied by sage-grouse during late summer.
10) Avoid construction of overhead lines and other perch sites in occupied sage-grouse habitat. Where these structures must be built, or presently exist, bury the lines, locate along existing utility corridors or modify the structures in key areas.
11) Control dust from roads and other surface disturbances.
12) Inform the public that dog training on sage-grouse outside the hunting season is illegal.

Residential Development

Little or no research is available that directly addresses the effects of residential development on sage-grouse, but some of the effects are obvious. Residential development can cause direct loss of lek sites and seasonal habitats and also fragment those habitats. Other factors that may impact sage-grouse populations include increased roads, fencing, power lines, human activity, and density of cats and dogs. In addition, new landfills/trash facilities may increase predator populations.

Research suggests that road-related disturbances during the breeding season may cause sage-grouse leks to become inactive over time, cause fewer hens bred on disturbed leks to initiate nests, and increases the distance from the lek hens will move to selected nesting habitat. Dust from roads and other surface disturbances can adversely affect plants and animals. Transmission and power line construction does not cause direct habitat loss, but sage-grouse tend to avoid areas associated with these lines (as they provide potential raptor perch sites), thus resulting in an indirect loss of habitat in the vicinity of overhead lines. The potential effects of noise on sage-grouse include masking sounds that influence courtship, mate selection, grouping, escape, etc.

Residential Development Goal

1) Minimize the impacts of residential development on sage-grouse habitats and populations.

Residential Development Recommended Management Practices

1) Encourage assimilation of sage-grouse information into county plans as they are developed. Develop and distribute appropriate literature for developers and county planners.
2) Limit free-roaming dogs and cats.
3) Maintain appropriate stocking rates of livestock on small acreages.
4) Encourage cluster development, road consolidation and common facilities that would have a reduced impact on sage-grouse.
5) Where necessary to build or maintain fences, evaluate whether increased visibility, alternate location, or different fence design will reduce hazards to flying grouse.
6) Maintain healthy sagebrush communities on small acreages.
7) Plan development to allow for sage-grouse movement.
8) Where possible protect habitat through conservation. (i.e. land exchanges, conservation easements, leases or CRP type programs)
9) Develop or locate funding sources to encourage maintenance or improvement of sage-grouse habitat on private lands.
10) Locate and manage sanitary landfills, dumps and trash transfer stations to eliminate predator impacts to sage-grouse.
11) Provide education on the effects of residential development on sage-grouse habitat and populations. Facilitate conservation districts and extension agents' ability to educate the public about sage-grouse.

12) Consider developing travel management plans that would allow seasonal closure and reclamation of roads.
13) Reduce noise from industrial development or traffic especially in breeding and brood-rearing habitats.
14) Avoid construction of overhead lines and other perch sites in occupied sage-grouse habitat. Where these structures must be built, or presently exist, bury the lines, locate along existing utility corridors or modify the structures in key areas.
15) Control dust from roads and other surface disturbances.

Vegetation Management

Of Wyoming's 62 million acres, approximately 32 million acres are dominated by sagebrush. Sagebrush communities evolved as dynamic landscapes with climatic and soil type variation driving changes in fire frequencies, and in adaptive development of different sagebrush species. These sagebrush communities occur commonly in tracts occupying hundreds or thousands of acres. The combination of active fire suppression and inappropriate livestock grazing are believed to have contributed to dense, old, monotypic stands of sagebrush, reduction of herbaceous understories, and simplification of community diversity. Habitat conversion, sagebrush habitat treatments, and the introduction of invasive species have also affected these sagebrush communities.

Historic sagebrush communities were a mosaic of successional shrub age classes created and maintained by fire cycles ranging in frequency from 10 to greater than 100 years depending on the sagebrush species and site. Patchy fires appear to have been the norm in most sagebrush communities; while larger fires at lower frequencies occurred in other areas, depending on climate, topography, plant composition, and aridity of the site.

Vegetation management can be achieved through biological, mechanical, or chemical treatments. Biological treatments include prescribed fire, designed domestic livestock grazing, and insect pathogens. Fire, floods, insects, mammal and bird herbivory, plant diseases and allelopathy (chemical inhibition) are also biological processes. Chemical treatments to manipulate, control, enhance or remove sagebrush include a variety of herbicides and fertilizer. Mechanical brush control treatments in sagebrush systems include mowing, roto-beating, chaining, disking, roller harrowing, railing, and blading. Reseeding and planting shrubs is also common.

The use of fire and other treatments for improving habitat should be evaluated carefully prior to implementation. Removal of large tracts of sagebrush is detrimental to sage-grouse populations. While some birds may be able to adjust by using adjacent sagebrush habitats, sage-grouse hens show fidelity for nesting in the same general area. Mosaic patches of sagebrush of different ages and structures benefit sage-grouse. Vegetation treatments influence the abundance and diversity of insects in sagebrush ecosystems. Use of vegetative treatments requires planning and understanding of the sagebrush ecosystem so that sufficient stands of desirable sagebrush remain. These stands should provide adequate cover and food for the appropriate seasonal habitat within the area being treated.

Ongoing research conducted in brood-rearing habitats indicates that sage-grouse tend to use untreated sagebrush habitat and adjacent treated areas or natural openings equally within 60 meters of the edge separating these two habitat types. Efforts should be made to maximize the amount of sagebrush grassland habitat that is within 60 meters (200 feet) of an edge of untreated area allowing the birds the greatest use of the treated area and maximizing brood-rearing benefits from treatment dollars. For instance where brood-rearing habitat is of the greatest concern, attempt to create treated and

untreated habitat patches no greater than 120 meters (400 feet) in width. This may be reflected in relatively long narrow or patchy burns rather than large treated areas. However, treatments will vary based on the seasonal habitat type.

Vegetation Management Goals

1) Restore, maintain and/or enhance sagebrush ecosystem health and ecological processes and functions including associated riparian systems.
2) Maintain or enhance natural patterns (e.g. seasonal migrations), functions (e.g. cover/food), and processes (e.g. fire).
3) Maintain sagebrush habitats with a healthy understory of native grasses and forbs, diversity of species, diversity of age classes, and patches of varying size and density.

Vegetation Management Recommended Management Practices

1) Develop priorities and implement habitat enhancements in areas currently occupied by sage-grouse.
2) Develop priorities and implement habitat enhancements in historical or potential sage-grouse habitats.
3) Develop and implement wildfire suppression guidelines that address sage-grouse habitat health and management.
4) Remove juniper and other conifers where they have invaded sagebrush sites important to sage-grouse.
5) Ensure vegetation treatments and post-treatment management actions are appropriate to the soil, climate, and landform of the area.
6) Recognize that fire provides a natural diversity component in sagebrush habitats; manage fire on a landscape and patch scale at a local level.
7) Prescribed fire in drier sagebrush communities should only be conducted where it is likely to promote sagebrush ecosystem health.
8) In higher-elevation, wetter sagebrush communities, prescribed fire should maintain, enhance or promote sagebrush ecosystem health by mimicking natural fire frequencies.
9) Where sage-grouse are present or desired, fire management objectives should recognize that fire generally burns the better sage-grouse nesting and severe winter habitat.
10) Evaluate all wildfires greater than 40 acres in occupied sage-grouse habitat to determine if rehabilitation of the burned area is needed with emphasis placed on habitats that would be susceptible to invasion by annual grasses.
11) When rehabilitation is necessary, the first priority is protection of the soil resource. Use appropriate mixtures of sagebrush, native grasses, and forbs that permit burned areas to recover to a sagebrush-perennial grass habitat.
12) Grazing management following sagebrush treatments or manipulations should be designed to benefit long-term sagebrush diversity and ecosystem health. Grazing management strategies should be designed to permit reestablishment of native sagebrush, grasses, and forbs that benefit sage-grouse.

13) Experiments in habitat manipulation should be relatively small in comparison to a specific grouse population.
14) Determine threshold levels of habitat alteration that can occur without negatively impacting specific sage-grouse populations. As a general rule, treat no more than 20% of any seasonal habitat type until results are evaluated.
15) Treat sagebrush in patches rather than contiguous blocks.
16) Protect patches of sagebrush within burned areas from disturbance and manipulation.
17) Consider all alternatives when designing sagebrush treatments.
18) Additional treatments in adjacent areas should be deferred until the previously treated area again provides suitable sage-grouse habitat.
19) Avoid removing sagebrush adjacent to sage-grouse foraging areas along riparian zones, meadows, lakebeds and farmland unless such removal is necessary to achieve habitat management goals.
20) Use mechanical or other appropriate treatments such as herbicides in areas with relatively high shrub cover (>30%) and a poor herbaceous component in order to improve brood-rearing habitats.
21) Implement effective monitoring plans to determine the effectiveness of vegetation treatments.
22) Develop and maintain cumulative records for all vegetation treatments to determine and evaluate site specific and cumulative impacts to sage-grouse habitats and identify best management practices for successful vegetation treatments.

Weather

Sage-grouse evolved with long term climatic change, and survived multiple ice-ages and droughts. Annual weather fluctuations, multi-year weather events, and long term climatic change all influence sage-grouse populations by physically stressing them and by modifying their habitats. Annual variations in precipitation and temperature can affect annual sage-grouse production and can be very site-specific. Cold, wet weather during early-brood-rearing can physically stress and kill young chicks and have adverse affects on insect populations. However, cool, wet springs can be advantageous to sage-grouse by promoting herbaceous growth, especially forbs. Extremely hot-dry conditions during the early summer concentrates sage-grouse on the few riparian areas that remain well hydrated, and thereby increase the potential for predation and the risk of disease. Typically, wet years are good for sage-grouse production and dry years can inhibit production.

Short-term climatic cycles affect the length of the growing season and influence plant succession and the abundance and duration of herbaceous cover and forb availability. Typically, wet cycles benefit sage-grouse while dry cycles or drought may reduce the amount of grass and forb production to levels that are inadequate for sage-grouse survival. Periodic weather events such as extreme winters can increase snow depths to levels that cover most of the sagebrush and limit areas available for foraging and cover. Long term and/or extreme drought can cause changes in vegetative communities that decrease the effectiveness of sage-grouse habitats for long periods, and result in reductions in productivity that culminate in population declines. A multi-year weather cycle of above normal precipitation can enhance sage-grouse populations; due to the positive influence moisture has on vegetative communities. Multi-year weather events usually occur on a larger geographical scale than annual fluctuations, and influence sage-grouse populations at the regional level.

Although sage-grouse have evolved with weather fluctuations for thousands of years, it remains a significant factor in determining the status and well being of their populations. Weather can have either a positive or negative affect upon sage-grouse populations, and wildlife managers must understand these effects in order to correctly assess the extent to which they are limiting a population or contributing to its decline. The short-term role that weather plays and long-term climate change effects on sage-grouse populations must be considered when management practices for sage-grouse are selected.

Weather Goals

1) Better define weather and climate related effects on sage-grouse populations and their interactions with other limiting factors in order to correctly understand and assess fluctuations in sage-grouse populations.
2) Determine cause and effect relationships between forage drought, multiple uses, and sage-grouse recruitment.

Weather Recommended Management Practices

1) Correlate, on a local level, historical and present weather data with historical and present sage-grouse population data to determine weather impacts to sage-grouse populations and habitat.
2) Where drought has been documented for 2 consecutive years, consider implementation of Recommended Management Practices in year 3 that may include drought management of livestock and wildlife grazing, protection of critical sage-grouse habitats from wildfire and prescribed fire, reduced bag limits during sage-grouse hunting seasons, predator management programs to enhance nesting and early-brood-rearing success of impacted populations, water hauling and protection of water sources from evaporation, installation of guzzlers, snow fences and fencing of water source overflows, insure bird ladders are in place on existing water sources and other appropriate management options developed by local sage-grouse working groups.
3) Correlate climate data with sage-grouse population distribution.

Habitat Assessment, Monitoring And Evaluation

One of the guiding goals and principles of this plan is to promote management that results in diverse, productive, and healthy sagebrush habitats for sage-grouse as well as other species that may use sagebrush environments.

The basic goal for habitat assessment, monitoring and evaluation is to maintain long-term conservation and, where feasible, enhance or restore diverse, healthy sagebrush ecosystems capable of providing seasonal sage-grouse habitat necessary to meet or exceed established population objectives. Monitoring and assessment should be addressed at multiple scales ranging from broad to fine-scale. At the finer scale, quantitative and qualitative habitat assessments, monitoring and evaluation can be delineated and defined by local working groups.

The basic habitat goal is no net loss in overall distribution and quality of the sagebrush ecosystem. Within any sage-grouse habitat management plan, there is a need to address landscape heterogeneity, site potential, site condition, and the seasonal habitat needs of sage-grouse, enhancing the ability of managers to maintain an optimal balance of shrubs, forbs, and grasses at the community and landscape level.

For most of Wyoming, it appears that while some big sagebrush communities have increased or decreased, the overall landscape is remarkably similar to pre-settlement times. Knight (1994) reported that pre-settlement sagebrush steppe might have been more varied where periodic fires were possible, creating patches of grassland and young sagebrush, and that sagebrush cover might be more uniform today as a result of fire suppression and livestock grazing practices. Even though the quantity of habitat lost appears relatively low, the long-term downward trend in sage-grouse populations remains a concern.

Fine-scale habitat assessments, monitoring and evaluations within identified or potential sage-grouse habitat should be conducted at various scales depending on the size and type of management action or project that is being evaluated. Small-scale projects may require assessments on a 40-acre scale while large projects may exceed 250,000 acres. Site-specific habitat assessments may range from evaluation of current sagebrush community health to habitat suitability, response of sagebrush community to land use activity or treatment and successional status and direction. It is critical that habitat and rangeland assessments include seasonal habitat mapping based on field data.

Information and data from broad-scale national or regional efforts and from mid-scale statewide efforts will often help form the basis for identifying fine-scale local field data collection and area mapping needs. Fine-scale, local project mapping and field evaluation will require interdisciplinary participation of sage-grouse population biologists, sagebrush habitat biologists, rangeland ecologists, soil specialists, other resource specialists, land managers, land users, local elected officials, landowners and other interested or affected parties or persons.

The use of ecological site descriptions and state-and-transition models for interpreting rangeland health and recognition of the dynamic nature, natural succession and range of variability within these communities lays the foundation for a sound scientific and ecological basis for sagebrush community assessments. Remote sensing image analysis, aerial photography and on-the-ground vegetation and cover type surveys can then be used to identify and monitor important sage-grouse seasonal habitats. This information will provide the basis for identifying response to current land management practices, habitat management activities and habitat treatments or restoration actions.

Habitat Assessment, Monitoring and Evaluation Goals

Broad-Scale:

1) Monitor and evaluate the distribution of sagebrush systems across Wyoming, which can or could support desired sage-grouse population objectives.
2) Monitor and evaluate the health, integrity and quality of sagebrush systems in Wyoming.

Mid-Scale:

1) Assess, monitor and evaluate shrub cover characteristics capable of supporting sage-grouse seasonal habitat requirements developed from Wyoming data and other applicable data sources. Information and data should include patch sizes, successional stages, shrub age structure, height, density, and distribution throughout the range of sagebrush ecosystems. Particular attention should be made to identify blocks, islands, corridors, and mosaic patterns and how they are arranged. It is important to maintain connectivity between habitat types.
2) Develop and continue to refine ecological site descriptions and state-and-transition model assessments based on rangeland health procedures. Incorporate sage-grouse habitat preference characteristics related to sagebrush cover, height, growth form, age class and sagebrush species to evaluate the relationship of these characteristics to herbaceous understory requirements for sage-grouse seasonal habitats in Wyoming.
3) Monitor and evaluate herbaceous understory characteristics with an emphasis on diversity of native forbs and grasses based on ecological site potential and successional status.
4) Restore and rehabilitate sagebrush communities where feasible, desirable or possible to maintain or enhance desired sage-grouse populations.

Fine-Scale:

1) Assess, monitor and evaluate the distribution and condition of sagebrush and herbaceous cover within desired condition for sage-grouse seasonal range.
2) Assess, monitor and evaluate the diversity and condition of the understory with emphasis on native species within desired condition for sage-grouse seasonal range.
3) Assess, monitor and evaluate vegetation characteristics, (i.e. shrub height, density, herbaceous structure and composition diversity) across the range of conditions desired for sage-grouse seasonal range.

4) Assess, monitor and evaluate restoration and rehabilitation possibilities in sagebrush communities with the potential to provide sage-grouse seasonal habitat.
5) Evaluate goals and objectives for sagebrush systems at the fine-scale based on:
    a. local knowledge about current habitat use;
    b. potential to support a variety of species including sage-grouse;
    c. existing native shrub patterns and sagebrush system associated characteristics;
    d. existing herbaceous cover and conditions;
    e. frequency and reasonably foreseeable likelihood of disturbance, e.g. fire;
    f. locations of seedlings or condition of shrub cover on adjacent areas; and
    g. importance of the area to seasonal needs of sage-grouse.

Research Needs

While many studies of sage-grouse and their habitats have been undertaken, there are still major issues and questions that remain unresolved. As a result, there is a need for additional mapping, research and data compilation. Local working groups should prioritize the need for data and information in their local area.

Mapping

1) Develop maps of current sage-grouse population seasonal use areas.
2) Develop maps of sage-grouse habitats for both statewide and local conservation planning and management efforts. Include documented positive or negative influences to sage-grouse or their habitat. (e.g. land treatments, wildfire, utility corridors, etc.)
3) Map vegetative type and seral stages in sage-grouse habitats. Evaluate quality of sagebrush habitats at local levels.
4) Identify and map canopy cover of sagebrush and herbaceous understory of sagebrush habitats. Evaluate habitat quality of herbaceous understory of sage-grouse habitats at local levels.
5) Develop mapping techniques that are consistent throughout the state.
6) Coordinate mapping efforts within and among agencies to eliminate duplication of effort.
7) Integrate sage-grouse mapping with other states where sage-grouse are a concern.
8) Periodically review and update maps to portray updated information on sage-grouse and their habitat.

Research

1) Encourage and fund long-term research studies.
2) Determine land management practices, particularly grazing management, that result in optimum forb and insect density, diversity, and abundance.
3) Determine the cause(s) of chick mortality during early brood-rearing.
4) Evaluate whether predator control aimed at increasing sage-grouse productivity is an effective management action.
5) Determine if changing predator species (e.g. increased red fox, raven, raccoon, etc.) impacts sage-grouse productivity.
6) Evaluate livestock grazing practice(s) as they relate to healthy sagebrush ecosystems and sage-grouse habitats.
7) Determine the effects of hunting on sage-grouse population sustainability.
8) Investigate the effects of habitat fragmentation on sage-grouse productivity and habitat selection.
9) Evaluate juxtaposition requirements between seasonal sage-grouse habitats (i.e. mosaic requirements for nesting and early brood-rearing habitats)
10) Evaluate the effects of pesticides on sage-grouse in rangeland applications.
11) Continue efforts to determine the effects of mineral development on sage-grouse populations.

12) Evaluate nest success based on sagebrush plant structure in addition to sagebrush and herbaceous plant cover and height.
13) Determine the impacts of West Nile Virus or other diseases on sage-grouse populations.
14) For all research projects, encourage consistency in design, methodology and reporting of data. Where design or methods are not consistent, clarify the differences.

Data Compilation

1) Prioritize sage-grouse populations by risk status throughout Wyoming.
2) Quantify invertebrate abundance and species composition changes over time
3) Analyze whether the historic shift from sheep to cattle has resulted in vegetative changes.
4) Correlate changes between alternate prey species abundance and sage-grouse abundance.
5) Correlate historical and present weather data with historical and present sage-grouse population data to determine weather impacts to sage-grouse populations and habitat.
6) Quantify possible effects of climate change on sagebrush and associated understory plant composition and distribution.
7) Quantify vegetative changes during the last 50 years in terms of overall cover, species composition, sagebrush community seral changes, and sagebrush: grass: forb: bare ground ratios. Investigate correlations between vegetative changes and sage-grouse population changes.

Endangered Species Act Listing Factors

The final product of the Wyoming Sage-Grouse Working Group is a Conservation Plan that addresses the five Endangered Species Act Listing Factors.

1. Present or threatened destruction, modification, or curtailment of habitat or range,
2. Overuse for commercial, recreational, scientific or educational purposes,
3. Disease or predation,
4. Inadequacy of existing regulatory mechanism,
5. Other natural or manmade factors affecting the species continued existence.